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Trends in the Pattern and Variability of Rainfall in the Loch Lomond Basin, Scotland

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Submitted for the degree of

Master of Science

1995

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by

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Abstract

The nature of present climatic change is causing general concern, mainly due to the assumption that this change is due to anthropogenic forcing.

This study aims to examine annual and seasonal changes in rainfall regime over West Central Scotland and to evaluate the consequent wider effects on the area. For this purpose 14 series of monthly rainfall data were analysed from the records from 28 sites within and outside the Loch Lomond basin in West Central Scotland. Each series includes all of the records available, the shortest has 18 years and the longest has 121 years of record, with some series composed of a grouping of several stations. Gaps in the records are filled in the series by estimation and the homogeneity of the final data set is checked.

The nature of temporal rainfall trends in pattern and variability over the Loch Lomond area is examined using different techniques of time-series analysis for annual (Oct.–Sep.), Winter half-year (Oct.–Mar.) and Summer half-year (Apr.–Sep.) rainfall amounts. The nature of spatial trends in the pattern and variability of rainfall is examined by isohyetal maps for standard periods of average annual rainfall. The different kinds of data presentation are examined for evidence of changes in the patterns of annual and seasonal increases and decreases in dry and wet years, and in terms of interannual rainfall variability. The overall trends and changes in spatial variability are also investigated.

The study confirms a marked trend towards increasing wetness over Central West Scotland during the last two decades as noted in earlier studies of wider coverage. From 1968/69 to 1991/92 the increase over the Loch Lomond basin was 76.6%. Furthermore it is demonstrated that this trend to increased rainfall has had no similar occurrence in the last 121 years, although important fluctuations have occurred. Spatially, the Northwest part of the Loch Lomond basin is wetter and the records indicate a greater rainfall increase in the recent two decades compared to the Southeast.

Possible causes of increasing rainfall related to changes in the general circulation and local conditions and the wider implications for the hydrological system and land use are discussed. The trends towards an increase in rainfall are consistent with theoretical experiments related to global warming linked with an enhanced 'greenhouse effect', but it is possible that they may reflect a return to conditions of earlier periods. The results of this study are particularly significant as they serve as a detailed indicator of climate change in West Central Scotland and constitute the basis for future planning of basin management in the Loch Lomond area.

Acknowledgements

First of all, I would like to express my gratitude to my supervisor, Dr. James Hansom, for all the help and encouragement he gave me at all stages of this project. His guidance during the research period was of great importance and the valuable comments and suggestions he made gave shape to this thesis. I would like to thank Dr. Hansom also for all comments, suggestions and corrections that greatly improved this dissertation.

All rainfall data used in this study was made available by the Meteorological Office — Past Weather Advice in Edinburgh. I would like to thank to Mrs. Beryl Hunter.

I would like to thank my colleagues Lydia Pierce, Karin Solimani and Derek McDougall who always gave words of encouragement and made my stay in the Geography Department a pleasant time.

Finally, I would like to thank my husband, João Correia Lopes, for his encouragement and all the help he gave me in using the computer programs needed for this research. He also helped with the presentation by formating this dissertation with LaTeX and by digitising and generating the final figures in encapsulated PostScript.

Ana Maria Ventura

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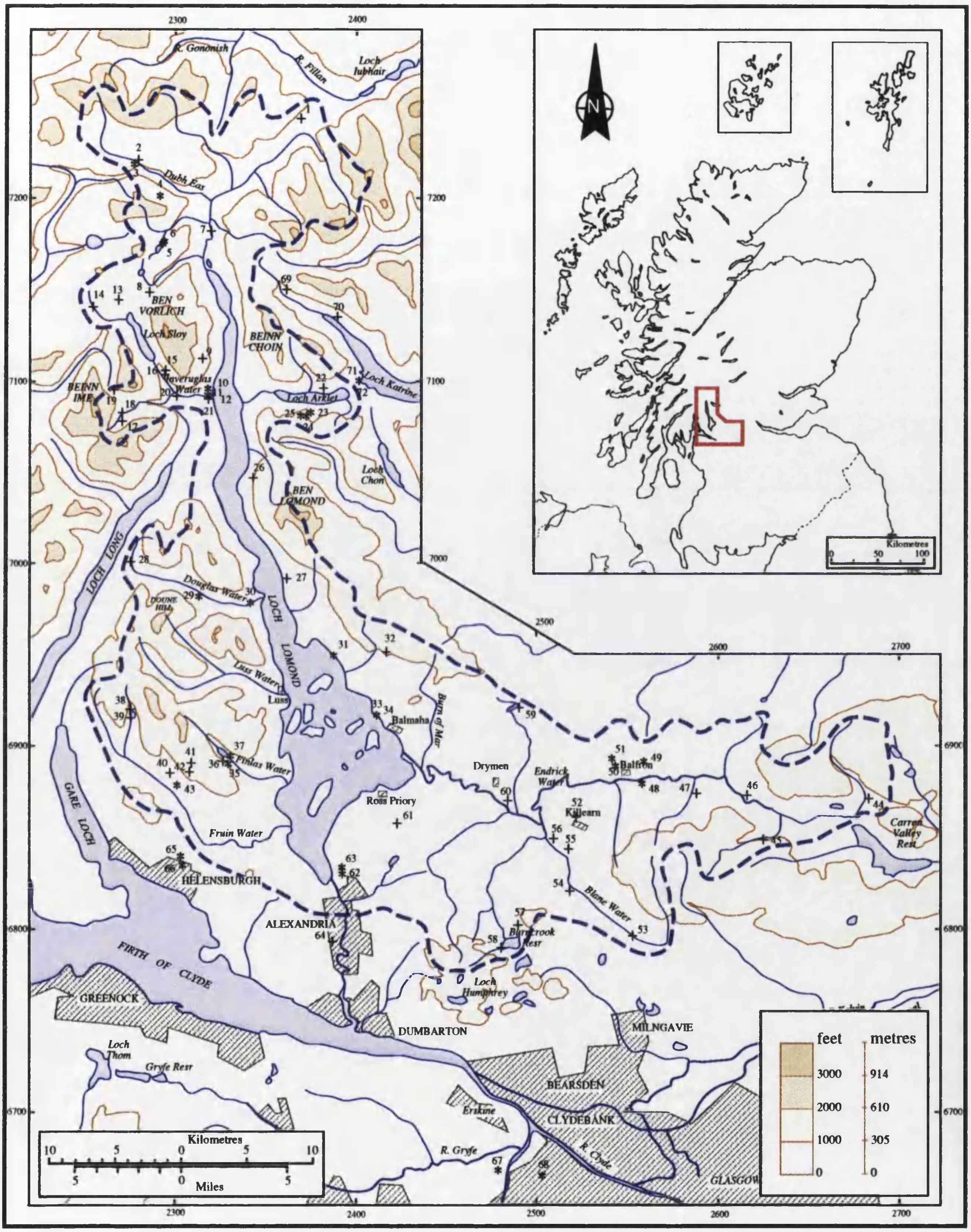

Frontispiece: Loch Lomond basin and rainfall station sites

Chapter 1

Introduction

To analyse observed climatic records is a task of topical interest since there is a pressing need to identify climatic variability on different temporal and spatial scales. This need is essentially a response to the developing consensus that the global climate system is increasingly subject to anthropogenic forcing. The most recent evidence of these effects are assessed by the United Nations Environmental Programme (UNEP) / World Meteorological Organization (WMO) in the International Panel on Climate Change (IPCC), which concluded that, if emissions of greenhouse gases[1] continue to rise, significant increases in temperature will occur, sea levels may rise and rainfall and other regional climatic patterns may change. These changes may have major natural, social and economic effects, the threat of which has induced an international response with the Climate Change Convention (CCC), concerned with the limitation of the increase in emissions of greenhouse gases to reduce the risk of producing dangerous climate change, which could incapacitate eco-systems to adapt or cause disruption in world food production [Bradley *et al.*, 1987; DoE, 1992; WMO/UNEP, 1990].

Climate changes could occur in a number of ways such as changes in the hydrological cycle, disruption of eco-system equilibrium and consequently impacts on economic aspects such as water resources, agriculture, industry, recreation and tourism, etc.

Temperature changes have attracted more attention than rainfall changes, but the latter have a potentially great impact with "the first signs of rainfall changes associated

[1] Greenhouse gases are essentially Water Vapour (H_2O), Carbon Dioxide (CO_2), Methane, Nitrous Oxide, which have significant natural and human sources, and the Chlorofluorocarbons (CFCs-11 and 12), which are produced industrially [WMO/UNEP, 1990].

with global warming might be expected to appear as trends in rainfall over this century" [Nicholls and Lavery, 1992].

1.1 This thesis

The present thesis (Trends in the Pattern and Variability of Rainfall in the Loch Lomond Basin, Scotland) is a contribution towards the understanding of rainfall variations over time and space at a local scale in the Loch Lomond basin since it is at these scales that real trends in rainfall amounts might be best detected at an early stage. The study attempts to identify the nature of the problem via some central questions:

1. are there temporal and spatial changes in the rainfall regime in West Central Scotland?

2. are these changes seasonal?

3. what wider effects might these changes have on the area?

1.1.1 The problem

Given that climate change has implications for both the natural and human environment, detailed studies of global, regional and local changes in present climate are urgently required. Rainfall is a vital element of climate which requires attention, especially in terms of changes and variability in time and space. Knowledge of past rainfall behaviour is essential to predictive studies and have import implications for successful environmental management.

Environmental studies in Scotland have recently begun to detect natural system change, particularly in the hydrological system, concluding that these changes are mainly related to increases in rainfall [Smith and Bennett, 1994]. The same authors reported that a sample of Scottish water managers expressed their high level of apprehension related to existing climate changes and its impact on water resources in Scotland, "coupled with concern for future conditions" [Smith and Bennett, 1994].

1.1.2 The aims

The present project, aims to establish:

1. whether there are changes in the rainfall regime in West Central Scotland;
2. whether these changes are seasonal; and
3. whether these changes have wider effects on the environment of the area

Specifically, the hypotheses under test are that:

1. rainfall values in West Central Scotland are subject to an increase in annual rainfall amounts;
2. these increases are concentrated particularly in the winter season; and
3. major hydrological change is already under way in the local environment of the area.

1.1.3 The study area — Loch Lomond basin

In order to test the above hypotheses it was necessary to identify a discrete catchment area in West Central Scotland. The Loch Lomond basin (see Figure 1.1) is an ideal area to test these ideas above, since:

1. it is located in West Central Scotland;
2. it is located in the transitional area between the lowlands and the highlands;
3. in terms of land/water use, its proximity to the Glasgow conurbation gives to the basin an importance not only for water supply but also for recreational use; and
4. the above factors make it a useful "barometer" for precipitation change trends in West Scotland.

1.1.4 Contributions of the study

One of the problems related to natural changes affecting the Loch Lomond basin is the possible change in the hydrological regime of the Loch and its tributaries, which is possibly related to an increase in rainfall.

The principal contribution of this work is to establish, in both the long and short term, the dimensions of rainfall changes over the Loch Lomond catchment area. This is achieved by establishing the temporal and spatial magnitude of the rainfall changes in

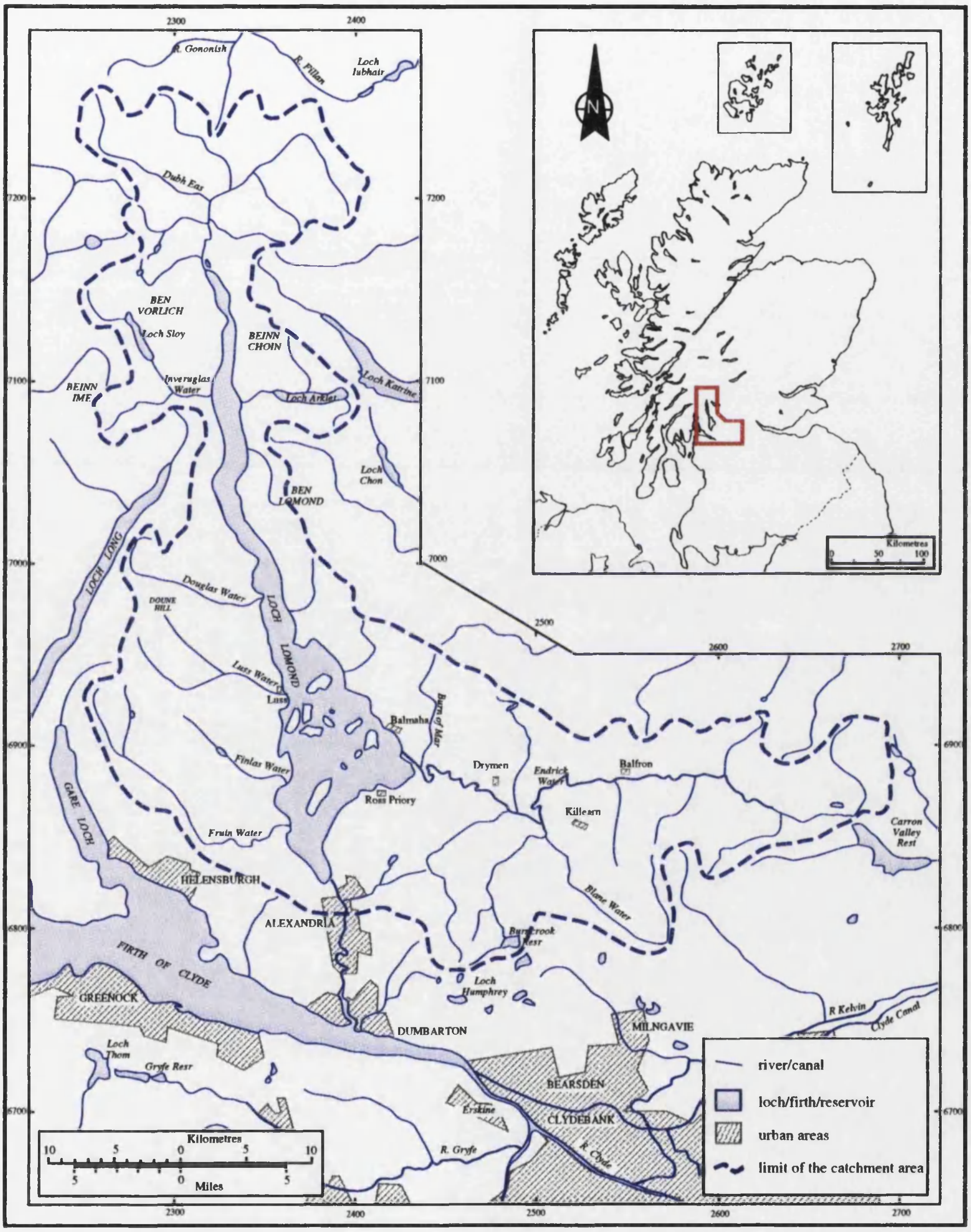

Figure 1.1: Loch Lomond basin and its location in West Central Scotland

terms of annual and seasonal variability, annual and seasonal trends and average annual spatial patterns.

It is also essential to compare the results from Loch Lomond with wider rainfall changes, identified in several studies in the literature reviewed. Some discussion of the major effects on the basin environment related to rainfall trends is also very important, especially for management proposes. Finally, it should be noted that this study is not aimed at projecting future trends per si, but some of the implications of an increase in rainfall are examined.

1.2 The research approach

Once the ideal catchment area was chosen to establish the aims of the present project, the research approach was defined. This study is essentially climatographic in nature with only a little incursion into applied and synoptic climatology. The study is based on a descriptive and statistical approach at the meso-scale, based on local temporal rainfall variations and on spatial rainfall variations within the basin.

The long and short term temporal analysis used is based on the available monthly data for selected rainfall stations from the area, with some estimated data filling the gaps in the data sets. These data were used to calculate seasonal (Winter and Summer half-year) and annual (hydro-meteorological year) rainfall amounts which forms the rainfall series used in the analysis.

The spatial analysis is based on isohyetal maps, elaborated from available data of 35 or 30 years average rainfall for all the rainfall stations for the standard periods 1916–50, 1941–70 and 1961–90.

1.3 Structure of this thesis

Chapter 2 is concerned with the description of annual and seasonal rainfall trends and variability and with spatial patterns of rainfall at different scales. This description is based on a literature review and contributes to later discussion of the trends and variability of rainfall patterns in the Loch Lomond basin. Annual and seasonal rainfall trends and variability are considered in the first section which is subdivided into different geographical scales, namely global, the Northern-hemisphere, Europe, the United Kingdom, Scotland and the Loch Lomond basin. In the second section patterns of rainfall are reviewed for Europe, the UK, Scotland and the Loch Lomond basin. In this chapter, the description of observational changes in rainfall, are touched on as well as the results of some climate models in predicting future changes. This is not an objective of the present study but provides a theoretical background for later discussion.

The methods used for data selection, its preparation and analysis are detailed in Chapter 3. The terminology used in the analysis is also introduced. The process of selecting and grouping rainfall stations from the existing network of stations in the Loch Lomond basin is described. Problems with coverage of data both in time and space are considered. To resolve the temporal problems of missing data nearby stations are grouped to maximise the time scale of the analysis, and in order to obtain a good spatial representation some short series are used. The consistency of the obtained series is then checked. The methodology used in the data analysis includes essentially statistical, graphical and cartographic techniques. Summary statistics, frequency, variability, time series and spatial analysis used are presented in this chapter.

In Chapter 4, reports of rainfall data selected for the Loch Lomond basin and description of the results of applying the chosen methods to the data are presented. Annual and seasonal rainfall in the Loch Lomond catchment area are described in terms of long and short-term variability. The rainfall variability of the area is assessed in terms of rainy and dry years and in terms of percentage of the mean. Rainfall fluctuations and trends are identified from raw data, five years running mean and a polynomial curve fit. Spatial patterns are described from average annual rainfall maps for the Loch Lomond catchment for three dates.

Chapter 5 is devoted to a general discussion of the methodology used and the results achieved for the Loch Lomond basin. Although much of the discussion is focussed on the results, the efficiency of the process used in selecting the stations, preparing and presenting the data is also assessed. The annual and seasonal rainfall variability, fluctuations and trends identified are summarised and compared with wider regional scales (Scotland and UK) and related to atmosphere circulation patterns. The average annual rainfall distribution over the basin is related to rainfall changes within the basin by location, orientation and topography. Finally the wider implications of increasing rainfall over the basin are pointed out.

The conclusions of the study are presented in Chapter 6, where all aims, results and discussion are summarised and an evaluation of the relevance of the work for climate changes and major effects within the basin is presented. The evaluation of the research approach, and suggested improvements to the project are also presented.

Chapter 2

Background and literature review

In the present chapter, changes in rainfall, as an important element of the climatic system, are reviewed at different temporal and spatial scales. Thus rainfall changes are investigated via temporal and spatial variability mainly to identify fluctuations, trends, inter-annual variability and spatial changes.

"Rainfall is a quantity which has great variations from site to site and for each site, through time" [Peixoto, 1987]. This variation from year to year (inter-annual variability) also includes variations at monthly and seasonal time scales. Most of us are sensitive to these short term variations in rainfall. Decadal variations are also easily noticeable when either deficit in precipitation causes droughts, or excess in precipitation causes floods. Nevertheless, variations within longer periods of time are identified by rainfall measurements or by using historical documents. In the present study, the rainfall variations are considered for modern times, just over a century of records for the Loch Lomond basin.

2.1 Rainfall trends and variability

Climatic changes are usually better documented in terms of temperature changes, yet several studies have been conducted on the direction of identification of rainfall changes at very different spatial scales, essentially over regions with severe problems related with rainfall changes as the Sahel region in Africa [Olaniran, 1991; Anyadike, 1993; Sivakumar, 1992; Kowal and Kassam, 1975]. Some research has also focussed on very local changes [Carniel *et al.*, 1990], whilst some is based on area-averaged rainfall [Flohn, 1984; Wigley *et al.*, 1984; Wigley and Jones, 1987; Gregory *et al.*, 1991; Tabony, 1981; Gregory, 1979;

Rupa Kumar *et al.*, 1992], and other using one site as representative of a larger area [Flohn, 1984; Nicholls and Lavery, 1992]. However the most recent research is related to global climatic changes, borne out of concerns about global warming apparently caused by the enhanced "greenhouse effect". Such research identifies observed climate variability and change and the relationship of the climate change to emissions of greenhouse gases, via climate modelling and prediction. Much of this research is performed by institutions and programmes as the World Meteorological Organisation (WMO), the United Nations Environment Programme (UNEP), the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP), the International Geosphere Biosphere Programme (IGBP) and the United Kingdom Meteorological Office (UKMO).

2.1.1 Global, Northern Hemisphere and Europe

There is a general concern that possible **global** changes in rainfall trends and variability may be driven by the global warming of 0.3 to 0.6^{o}C that has occurred over the past century, resulting from an enhanced "greenhouse effect" [DoE, 1991]. In light of the importance of changing climate to water resources, various studies and reports have been focussed attention on changes in temperature and rainfall as a consequence of increasing CO_2 levels. However, whilst the relationship between temperature changes and increasing CO_2 levels has been established, the same relationship has not yet been convincingly established for precipitation and CO_2 levels.

During the 1980s General Circulation Models (GCMs) of the Earth's atmosphere have been used to predict future climatic changes in response to doubling of CO_2 in the atmosphere, by five different groups — Oregon State University (OSU; Schlesinger and Zhao, 1989), United Kingdom Meteorological Office (UKMO; Wilson and Mitchel, 1987), Geophysical Fluid Dynamics Laboratory (GFDL;Wetherald and Manabe, 1986), Goddard Institute for Space Studies (GISS; Hansen et al., 1984), National Center for Atmospheric Research (NCAR; Washington and Meehl, 1984). They predict a global precipitation change of +7.8%, +15%, +8.7%, +11% and +7.1% respectively, accompanying a global warming of 2.8^{o}C, 5.2^{o}C, 4.0^{o}C, 4.2^{o}C and 3.5^{o}C respectively, if the CO_2 concentration doubled [Goodess *et al.*, 1992]. These conclusions about changes in rainfall and temperature have increased the concern about the potential climatic effects of an increase in CO_2 and other radioactive active trace gases in the atmosphere.

Although "precipitation variations of practical significance have been documented in a number of regions on many time and space scales, [the Intergovernmental Panel on Climate Change (IPCC)[1] in its more recent supplementary report concluded that] due to data coverage and inhomogeneity problems nothing can be said about global changes [because there is] no firm new evidence of global-scale multidecadal rainfall trends" [IPCC, 1992].

The most notable changes in precipitation over one region, presented in the IPCC supplementary report are:

1. the drought epoch, extended into its third decade, over the Sahel region of North Africa, "the largest observed regional percentage change in precipitation", and
2. "a notable increase of precipitation over the [ex-]USSR, South of 70° N during the last century" [IPCC, 1992].

In the light of the importance of a large-scale change in climate, some recent studies have investigated annual and seasonal changes in precipitation on hemispheric and large regional scales [Bradley *et al.*, 1987; Tabony, 1981; Rupa Kumar *et al.*, 1992; Nicholls and Lavery, 1992; Karl and Riebsame, 1989; Yu and Neil, 1991; Vines, 1985].

Over **Northern hemisphere** land areas "the trends in zonally averaged precipitation over the last 30 to 40 years are similar to changes predicted by GCMs experiments with doubled CO_2 levels", i.e. increases over 35–70° N and decreases (for most of the models) over 5–35° N, which could be an "additional indicator (together with temperature) in the evaluation of CO_2-induced climate change". Seasonally, for the land areas of the hemisphere, there are trends toward higher precipitation levels in Autumn and Winter, for the entire period of records (last 130 years) [Bradley *et al.*, 1987]. Also obvious are the two major rainfall trends recorded in the World, the decreasing trend for Northern Africa and Middle East and the increasing trend for the ex-Soviet Union.

For **Europe** as a whole, in 1987 Bradley et al. found that annual precipitation has

[1]The IPCC report is a result of international action "to tackle the threat of climate change", in order to provide the basis of a global response to the climate change by a framework "Convention on Climate Change" (CCC) to be signed during the United Nations Conference on Environment and Development (UNCED) in Brazil in June 1992 [DoE, 1991]. The IPCC is supported by the WMO and UNEP and is organised by three working groups: **Science**, to assess the available scientific information on climate change; **Impacts**, to assess the environmental and socio-economic impacts of climate change and **Response**, to formulate response strategies [IPCC, 1992]

increased since the mid-19th century with increases in Winter, small increases in Autumn and Spring and recently a slight decline in Summer rainfall.

Time changes and variability over Europe, based on instrumental observations were also analysed in 1984 by H. Flohn, using the area-averaged series available at the time, (Netherlands, United Kingdom (UK) and ex-FRG) and some individual stations scattered over Europe, who concluded that "most series of homogeneous records and of area-averaged precipitation show an unexpected degree of coherence". The most salient common feature is an increase of Winter precipitation, 10–15% higher than in the 19th century. German and Dutch series presented the highest 30-years Winter average. The anomalies are for Rome with a significant decrease in Winter between 1905 and 1960 and for British stations where "high values like those around 1960 were also observed much earlier (1760 and 1810)." For Summer the degree of coherence between series is only slightly weaker than for Winter, with the highest averages centred around 1955 and 1840–50 or 1867 and the minima centred around 1907 [Flohn, 1984].

Precipitation is predicted, by the highest resolution models, "to increase on average in middle and high latitude continents in Winter (by some 5–10% over 35–55^{o} N)" [WMO/UNEP, 1990]. Recently "The Hadley Centre Transient Climate Change Experiment" (HCTCCCE, 1992) model results, over Western Europe, shows that "Winter precipitation increases rapidly during the first three decades of the experiment and then remains relatively steady at an average increase of about 0.3 mm per day. In Summer the precipitation decreases by about 0.2 mm per day by year 70, but the decadal variability in Summer is much greater" (Figure 2.1).

Over global, hemispheric or European scales, rainfall trends, whether annual or seasonal analysis shows great variability. Those "changes in variability as well as the mean climate are important in the assessment of the impacts of climate change" [Mitchell, 1990]. Some authors consider that "variability is more important than averages [with a] sensitivity of extreme events to the mean and variability of climate" [Katz and Brown, 1992].

Relative to the inter-annual variability, in 1984 H. Flohn found similar Winter and Summer results, to be at a minimum around 1895–1900 and higher variability centred between 1950 and 1960.

Possible trends in rainfall and temperature interannual variability in the 21st century was investigated in 1989 by Rind et al. whose concluded that "the sign of the change is

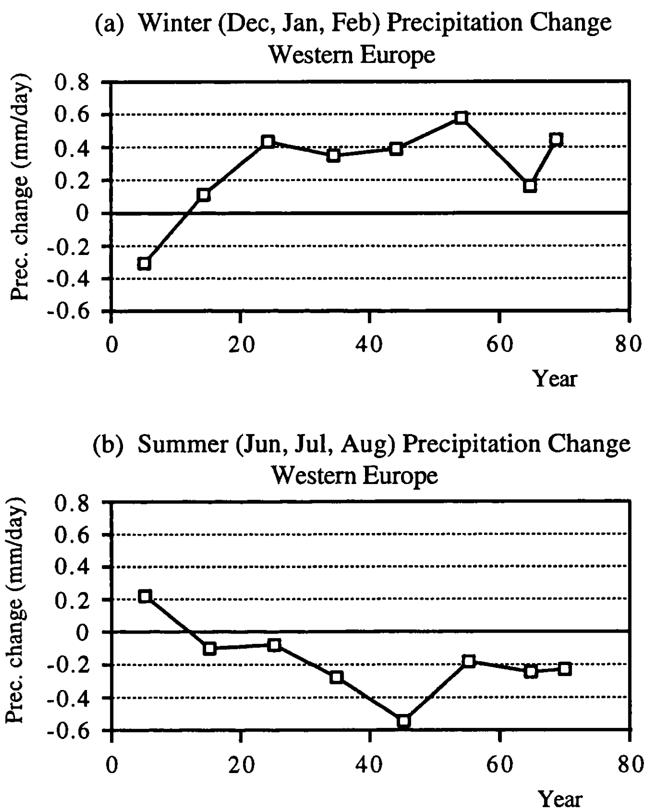

Figure 2.1: (a) Winter (Dec, Jan, Feb) and (b) Summer (Jun, Jul, Aug) precipitation changes for Western Europe derived from the Hadley Centre Transient Climate Change Experiment. The horizontal dashed lines indicate the 95% level of confidence [HCCPR, 1992].

significant, with temperature variability decreasing and precipitation variability increasing (as mean precipitation increases)" [Rind *et al.*, 1989]

Another recent report has pointed out that "there is no clear evidence that weather variability will change in future" "with the possible exception of an increase in the number of intense showers" [WMO/UNEP, 1990]. In terms of modelled inter-annual variability for western Europe "somewhat larger than that observed, but, on a global scale, there is no expectation that the inter-annual variability will change in a warmer World" [HCCPR, 1992].

2.1.2 United Kingdom

The British Isles are usually very wet throughout the year, that wetness caused by rain "more often light and persistent" [Lamb, 1964]. Nevertheless, in spite of a generally variable weather which gives an uncertainty to the British seasons, "natural seasons may be distinguished in terms of weather types" [Stringer, 1972].

Rainfall over Britain has been studied for a long time, partially because of the excellent availability of data. Observations have been taken for over 200 years and were improved in the mid-nineteenth century with the creation of the British rainfall organisation and the journal British Rainfall led by G. Symons. His work was continued by H. R. Mill and M. de C. S. Salter (1915) who described spatial distributions of monthly and annual rainfall and by Glasspoole (mid-twenties to about 1950), who produced work related with spatial distributed, temporal changes and variability of the rainfall over Britain [Atkinson and Smithson, 1976; Wigley *et al.*, 1984].

More recent studies have focussed on investigations of monthly, seasonal and annual amounts at single stations, for example in 1974, C. G. Smith for Oxford, in 1956, Reynolds for Bidstone, in 1968, Milner for Sheffield and in 1973, Wales-Smith for Kew [Wright, 1976].

Other studies have examined temporal patterns in rainfall based on averages over a number of stations. In 1972 Davis identified changes in rainfall using decade mean rainfall totals, for the period 1910–69, and mean monthly rainfall, for the periods 1911–40 and 1941–70, at 6 particular stations and for Scotland and for England and Wales, as large regions. His results for the 2 regions are presented in Figure 2.2 and in Figure 2.3. They show generally downward trends in Winter with a slight increase in Scotland after 1950s and upward trends with fluctuations in Summer, resulting in an annual increasing trend

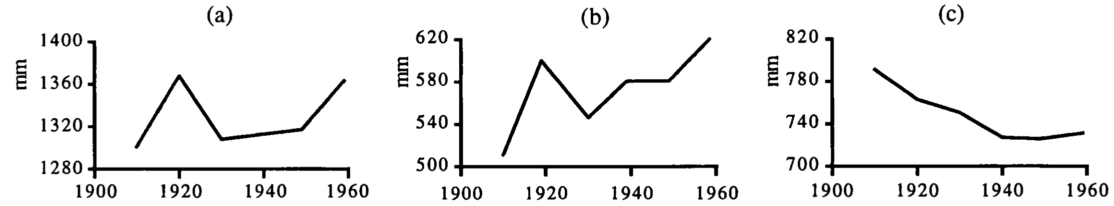

Figure 2.2: Trends in decade mean rainfall totals, 1910–69 (a) year (b) April to September (c) October to March for Scotland [Wright, 1976].

from the 1940s, and for 1930s in Scotland. From the monthly analysis the conclusion is that "the Summer half of the year (except July) became generally wetter, the Winter half drier" [Wright, 1976].

In 1975 Gregory defined regions based on annual rainfall fluctuations of 50 stations from 1881–1950 (70 years) using different methods in a comparative analysis. He compared the defined regions using graphical methods, linkage analysis, factor analytical techniques - direct, orthogonally rotated and oblique rotation solutions of a principal components analysis - (see Figure 2.4). He concluded that the direct and rotated solutions of factor analytical techniques are preferable to the graphical approach because "the direct solution emphasises the gradient of the pattern of change and presents a bases for synoptic interpretation [... and] the rotated solutions [...] provide the most distinctive units of change" [Gregory, 1975].

Later on in 1979 Gregory applied the definition of significantly wet or dry decades to the regional units of annual rainfall fluctuation, 1981–1950 derived from an orthogonal rotated principal components analysis. His results for region C (see Figure 2.4 (d)), which includes the West of Scotland, are presented here in Figure 2.5.

Thus the regional analysis is based on the resultant graphs and for region C the 1981–97 period was "mainly below average, with dry decades in 1984–93 to 1988–97". The period from 1998 to 1940 had "no significant concentration of either wetter or dry years, the only apparent tendency in this direction being 1916–28, the first half of which was dominantly below average and the later half mainly above average". Finally 1941–50 was a wet decade [Gregory, 1979], which is concordant with the increasing rainfall trend identified for Scotland as a whole by Davies in 1972.

More recently the spatial and temporal variability of precipitation over England and

Figure 2.3: Changes in mean monthly rainfall, 1941–70 minus 1911–40, for Scotland and England and Wales [Wright, 1976].

Wales for the period 1961–1970 was examined [Wigley *et al.*, 1984], and updated to 1985 by Wigley and Jones (1987) who found some evidence of changes in variability. In this second study the main conclusions about changes in seasonal and annual precipitation for the sub-regions defined in the first study were: "considerable variability from year to year; noticeable inter-decadal fluctuations; no overall long-term trends" [Wigley and Jones, 1987], which are evident in Figure 2.6 for annual, Winter and Summer. Furthermore they discussed the precipitation extremes and concluded that "there have been marked changes in the frequencies of monthly and longer time-scale extreme events both in the last 55 years relative to the 220 years, and in the last 10 years relative to the last 55 years". These studies concluded that there was a "recent increase in the frequencies of dry summers and wet winters and springs" in England and Wales [Wigley and Jones, 1987]. Later, the last two studies referred, are extended and updated to the whole UK [Gregory *et al.*, 1991]. The UK was divided into nine regions of coherent precipitation variability described in Table 2.1 and represented in Figure 2.7. From area-average annual series, the authors plotted the results in order to check for trends (Figure 2.8) and concluded that "no long-term trend is readily apparent. There are a decadal time-scale upward trend in Scotland but this cannot be regarded as unusual in the context of longer time-scales" [Gregory *et al.*, 1991].

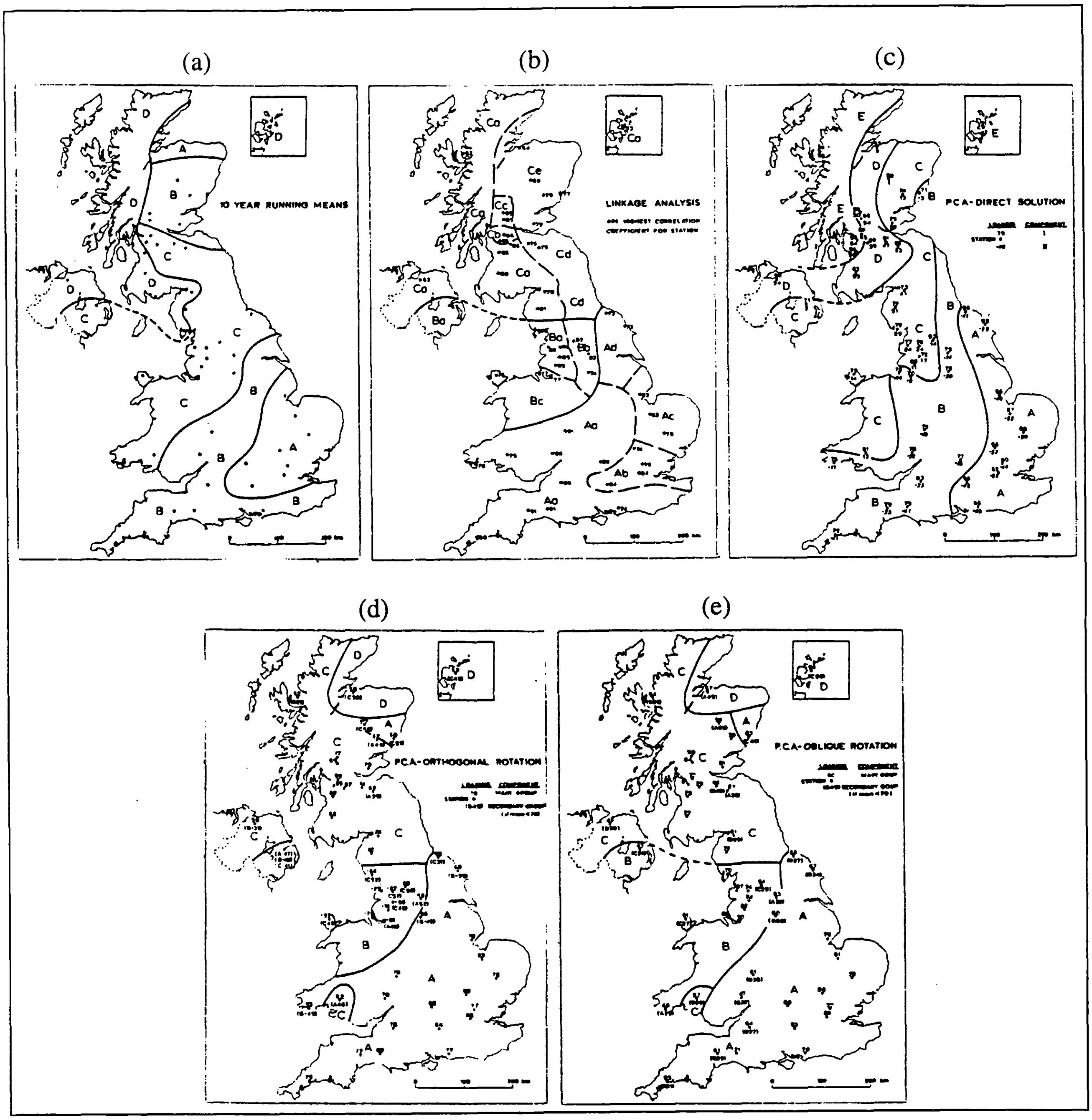

Figure 2.4: Regions of annual rainfall fluctuations (1881–1950) based on (a) 10-year running mean graphs, (b) linkage analysis and (c) the direct solution, (d) an orthogonally rotated (varimax) and (e) an obliquely rotated solutions of a principal components analysis [Gregory, 1975].

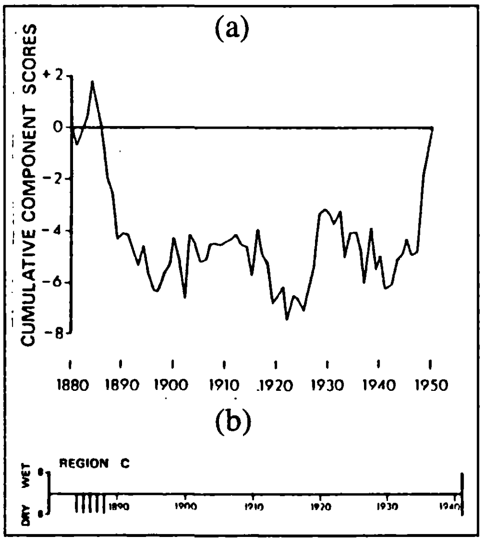

Figure 2.5: (a) Cumulative curves of wetness indices derived from components scores and (b) wet/dry decades based on wetness indices for region C, 1981–1950 [Gregory, 1979].

NS	North-West and North Scotland
SS	South-West and South Scotland
ES	East Scotland
NWE	North-West England and North Wales
NEE	North-East England
NI	Northern Ireland
CE	Central and east England
SWE	South-West England and South Wales
SEE	South-East England

Table 2.1: UK regions of coherent precipitation variability [Gregory *et al.*, 1991].

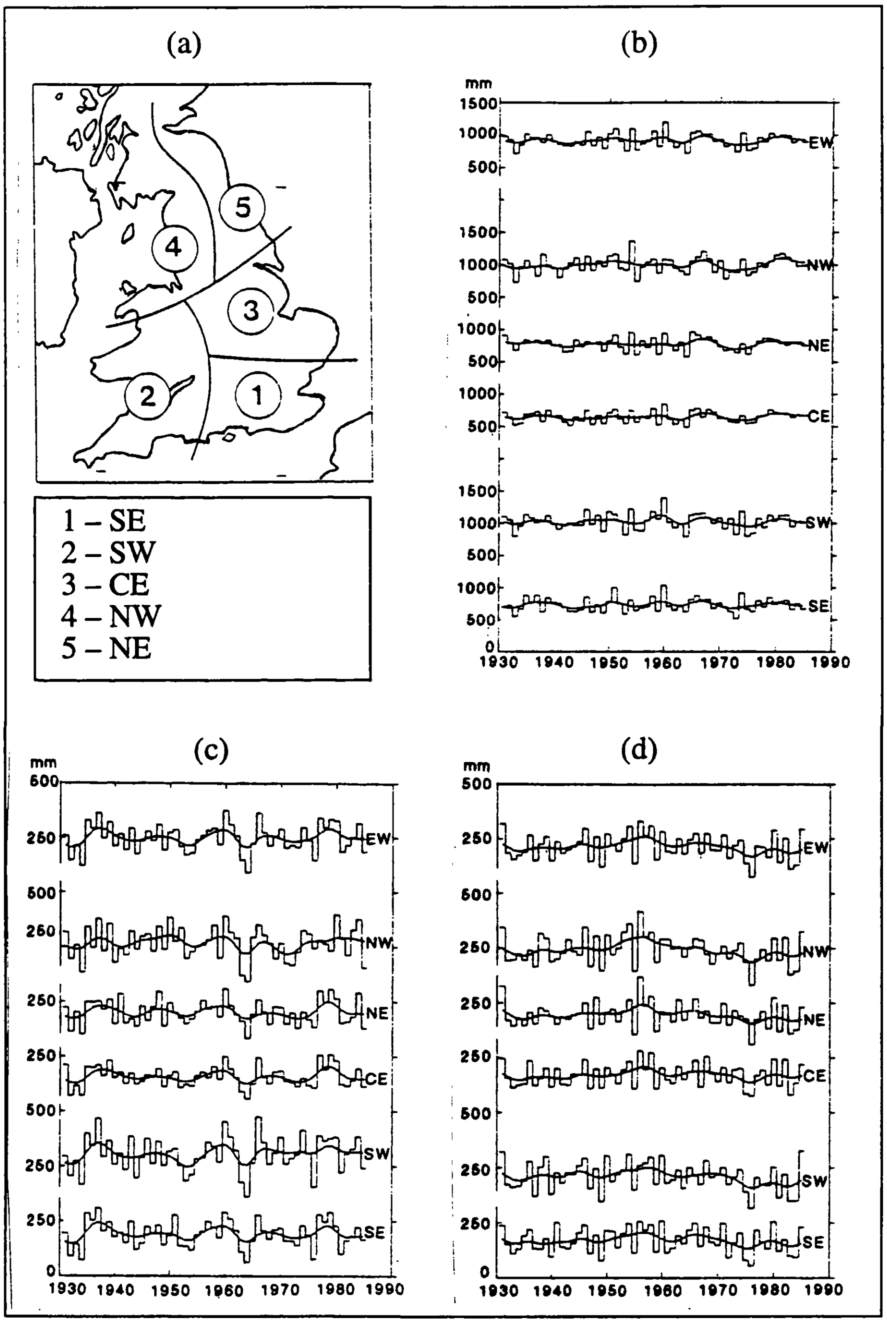

Figure 2.6: Precipitation variation, 1931–85, (b) annual (calendar year), (c) Winter (DJF) and (d) Summer (JJA) for the whole East West (EW) area of England and Wales and (a) for the five coherent precipitation regions [Wigley and Jones, 1987].

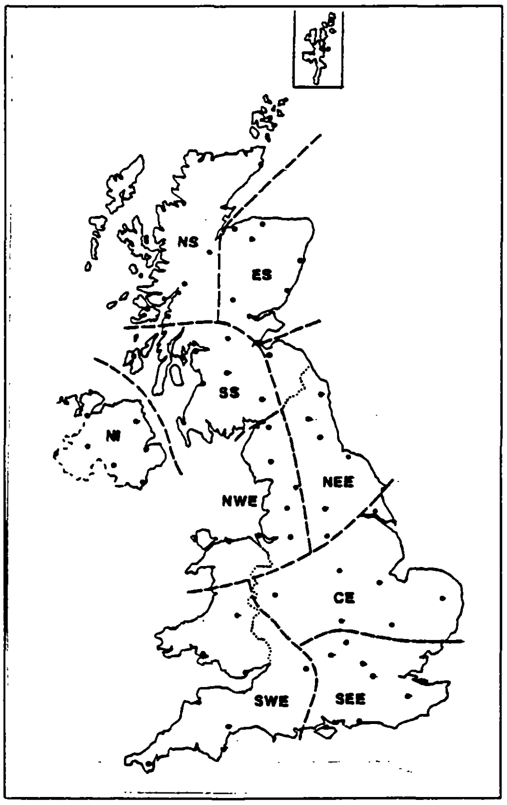

Figure 2.7: Division of Britain into nine regions of coherent rainfall variability [Gregory *et al.*, 1991].

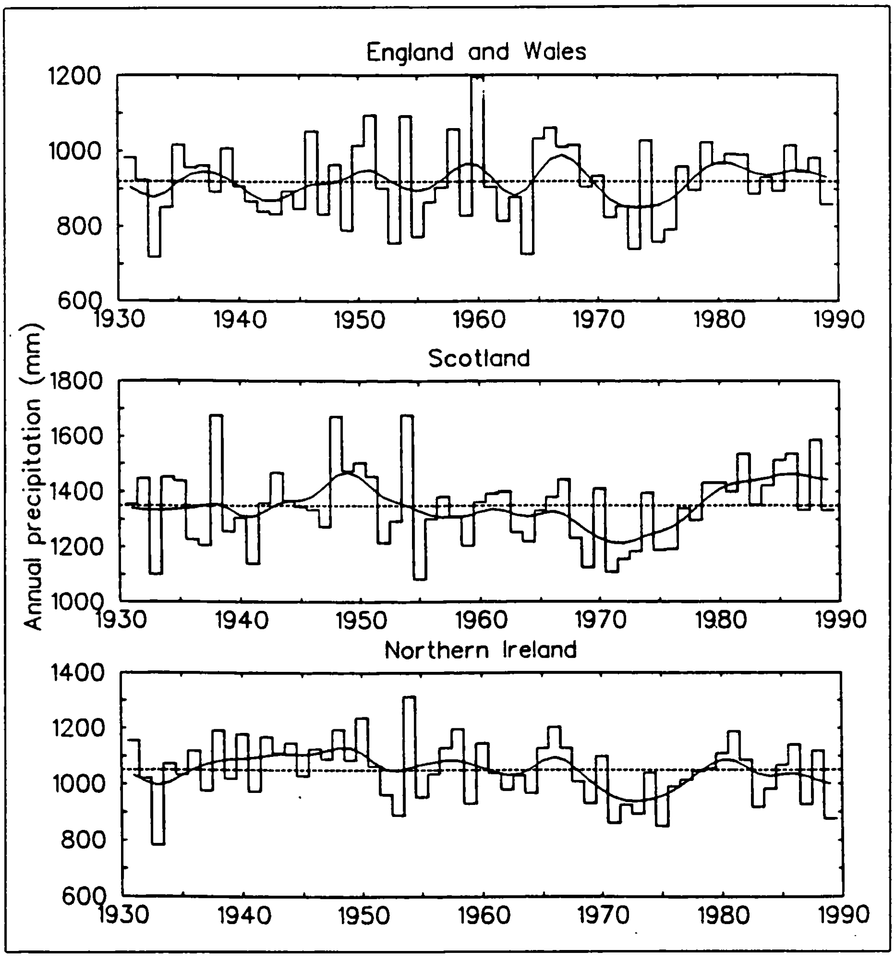

Figure 2.8: Annual precipitation totals for 1931–89 [Gregory *et al.*, 1991].

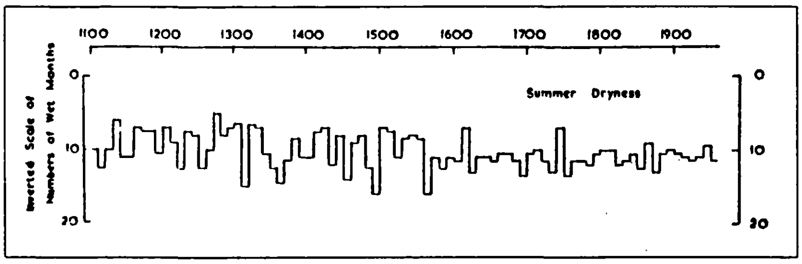

Figure 2.9: Numerical indices of Summer dryness in England for each decade from 1100 to 1959 [Lamb, 1964].

Rainfall is in general a very variable meteorological element both in space and time. This variability can be observed on different time-scales, over days, seasons, years, decades or even longer periods. Figure 2.9 shows the variability in rainfall in England by decade from 1100 to 1959 in terms of Summer (July and August) dryness [Lamb, 1964]. Fluctuations are noted, but the most evident feature is the reduction in decadal variability in the last centuries.

Wright refers to results by Senior in 1969 in which the inter-annual variability of annual rainfall in Britain did not show great changes from 1901–30 to 1931–60, but whilst "in Scotland the highest values shifted from the East to the West [...] in England and Wales highest variability became more concentrated in the East" [Wright, 1976].

The "Hadley Centre Transient Climate Change Experiment" current model suggests that "changes over the UK are generally similar [to the Western Europe climate changes], although temperature changes in Summer are expected to be somewhat less than the Western European average" [HCCPR, 1992].

Scenarios of UK climate change are reported, as outcomes suggested by climate models in the first report prepared at the request of the Department of the Environment (Jan. 1991) by the UK Climate Change Impacts Review Group. They concluded that in Winter, the best estimate rainfall is for an increase (5% higher in 2030 and 8% in 2050) to happen. In Summer there is more uncertainty because the model results are different in direction and amount. Nevertheless it is considered that the best estimate is probably for no change in Summer rainfall, with an uncertainty of ± 11% in 2030 and ± 16% in 2050. However the working group have clearly pointed out that "patterns of precipitation changes predicted by GCMs are very unreadable" because of the "difficulties in simulating the present precipitation patters accurately at the regional scale" and because of "the differences between

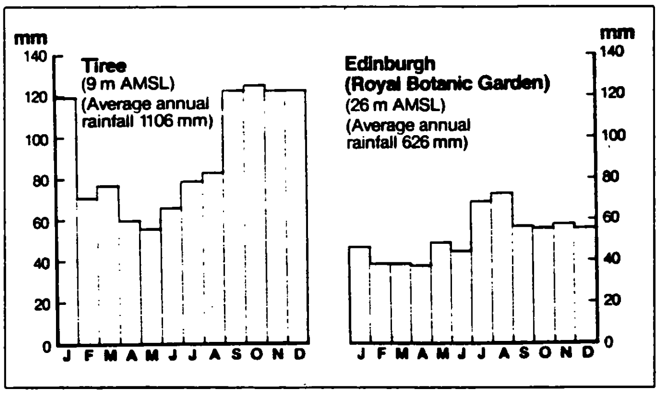

Figure 2.10: Average monthly rainfall (1951–80) [MetOffice, 1989].

GCMs for CO_2 experiments". As a result, the conclusions "must be regarded useful only as scenarios" [CCIRG, 1990].

2.1.3 West of Scotland and Loch Lomond area

Though generally described as having a very humid climate, Scotland has wide seasonal, spatial and temporal variations. Much of the West part of Scotland has long term averages of annual rainfall exceeding 1600 mm, calculated by the Meteorological Office from actual measurements, whilst the East coast has less than 800 mm. Adding to this contrast of annual amounts, contrasts of seasonal distribution of precipitation are also encountered. Thus, in the West of Scotland there are very marked seasonal variations in average monthly rainfall, "with the total rainfall for the five months from February to June being only about 55% to 60% of that from September to January", while in the East there are less marked seasonal differences with the wettest months being July and August. These are illustrated in Figure 2.10 for Tiree in the Hebrides (West coast) and Edinburgh (East coast). The contrast in the seasonal cycle between three regions of coherent rainfall variability over Scotland (NS, SS and ES) is also noted in Figure 2.11. The strongest seasonal cycle is observed "in northern and western regions of Scotland" [Gregory *et al.*, 1991]. The differences in rainfall regimes between Scottish regions is also reflected by the correlation coefficients for the annual time-series for different regions (Figure 2.12). In this figure is evident the weak correlation (20) between the North-West and North Scotland region (NS) and the East Scotland region (ES).

The Loch Lomond basin marks "from a line which runs roughly mid-way across the

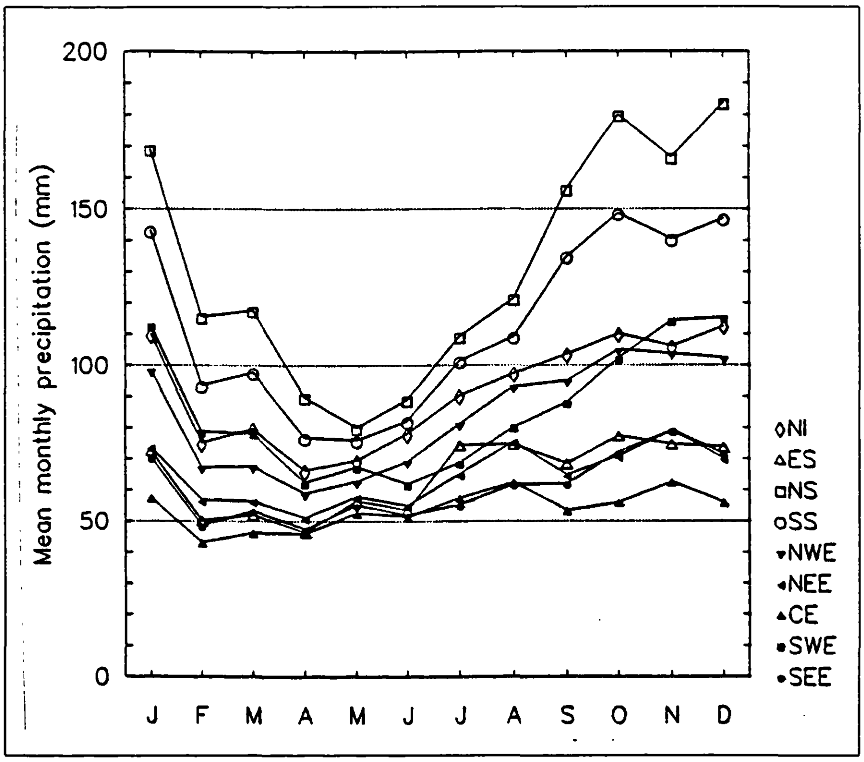

Figure 2.11: Mean monthly precipitation amounts for the UK nine regions [Gregory *et al.*, 1991].

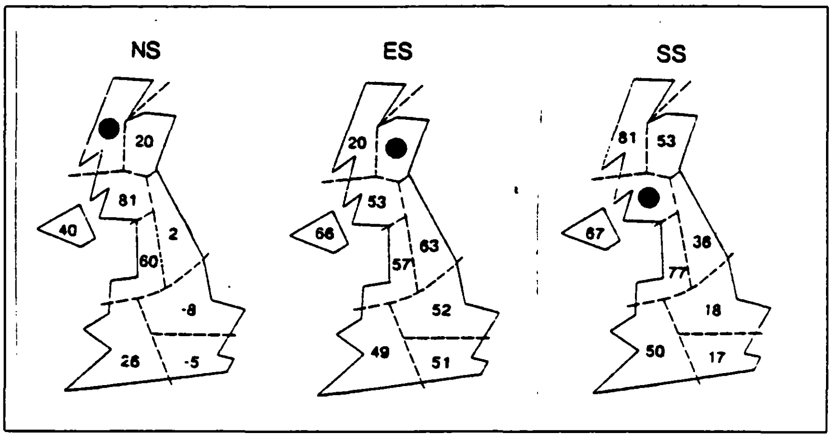

Figure 2.12: Correlation coefficients for the annual time-series between the indicated region and each of the others [Gregory *et al.*, 1991].

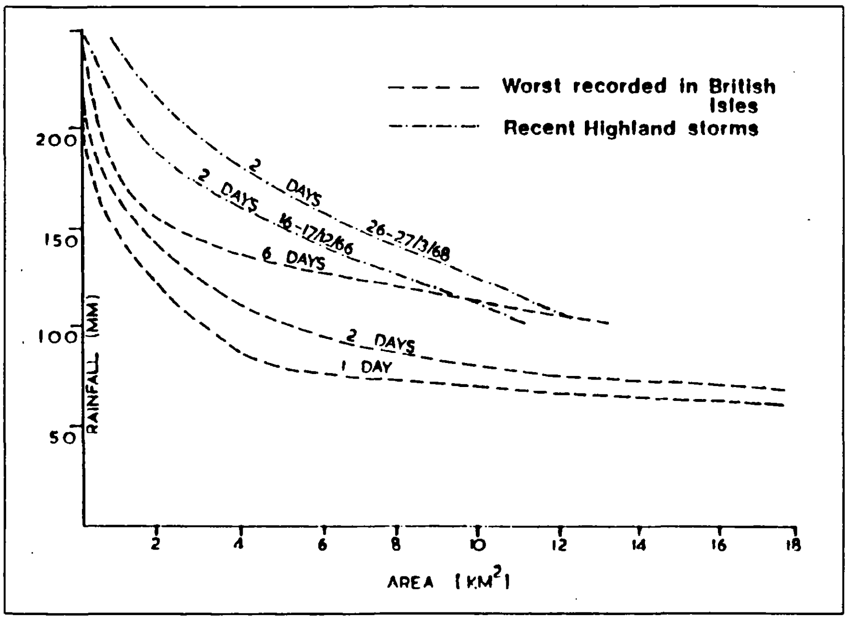

Figure 2.13: Largest areas in the British Isles with rainfall exceeding certain values during six, two and one rainfall days [Reynolds, 1985].

Loch" the transition between the Köppen climatic type Cfb over the South-western part to Cfc over the Northern part [Jones, 1991]. Taking into consideration the regions presented in Figure 2.7, the northern of Loch Lomond basin is located in the transitional area from North-West and North Scotland region (NS) to South-West and South Scotland region (SS).

Studies of rainfall changes over Scotland have been focussed on recent changes, particularly extreme rainfall events, and its effects on streamflow, Loch levels, water resources, vegetation and management. Such extreme rainfall events have influence on annual variability.

Extremely high rainfall events were recorded in the Highlands of Scotland in December 1966 and March 1968 and analysed by Reynolds, who noted that "nothing like either of them has ever been recorded before [...] anywhere in the British Isles" [Reynolds, 1985] (see Figure 2.13). At Loch Sloy, in the Loch Lomond basin, a new maximum rainfall in a day for Scotland was recorded on 17 January 1974 [MetOffice, 1989].

In the last two decades increases in both magnitude and frequency of flood events have been documented. From 1971 to 1985 a rise in flood frequency in the Allan catchment, central Scotland, was related to increases in Autumn and Winter rainfall [Rowling, 1989].

Smith and Bennett (1993) demonstrated, by analysis of annual, seasonal and extreme

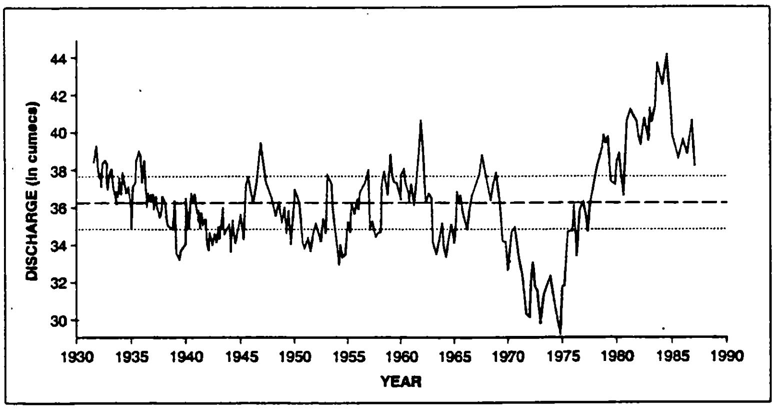

Figure 2.14: Four-year running mean of average daily flows for the river Dee at Woodend between 1929 and 1989 with confidence lines at ± 2 SE [Smith and Bennett, 1994].

monthly riverflows in six key catchment areas, that "a marked trend to increasing wetness over Scotland, amounting to around 40% in terms of yearly mean flows during the 1970–89 period" had occurred [Smith and Bennett, 1994]. Figure 2.14 shows this trend for the river Dee at Woodend in Grampian region. Smith and Bennett also referred to notable flood events in the late 1980s and early 1990s and consistently higher flows within the Clyde basin.

What is clear from the literature is that there is a need for a systematic analysis of recent rainfall changes in comparison with past changes, for the Loch Lomond basin. Such an analysis is one of the aims of this study and is performed on annual and seasonal time-scales, by stations or group of stations for the Loch Lomond catchment area. Analysis of the relationships between rainfall changes and the subsequent effects over the area is a natural extension, but is not in the scope of the present study.

2.2 Spatial patterns of rainfall

New spatial patterns of rainfall are expected in the face of possible changes in rainfall trends and variability. The prediction of 15% increases in precipitation, by the UKMO model, is not equally distributed, but "the spatial scale of the change is smaller than for temperature [and] there is little agreement between the regional details of the changes in precipitation" [Mitchell, 1990], whereas "most models suggest precipitation decreases in tropical and subtropical regions, in agreement with observed conditions since 1950" [Bradley *et al.*, 1987].

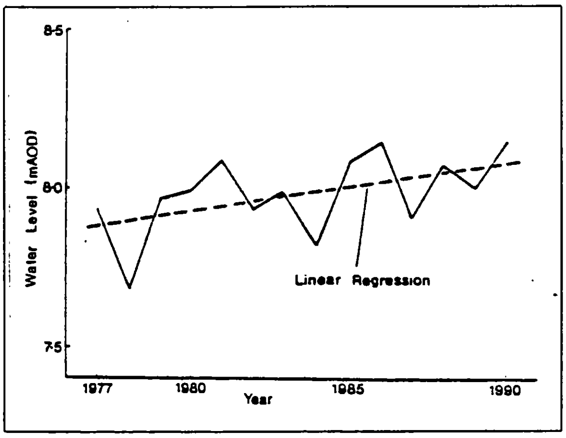

Figure 2.15: Annual average water level in L.L. at Ross Priory (1977–90) [Curran and Poodle, 1991].

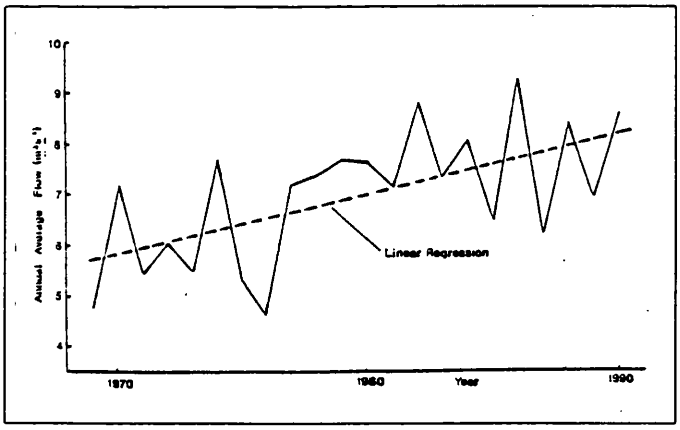

Figure 2.16: Annual average flow of the Endrick Water (1969–90) [Curran and Poodle, 1991].

2.2.1 Europe

The spatial patterns of precipitation change "over Western Europe, for the decade centred on the time of doubling of the atmospheric concentration of CO_2 — model years 66–75" are shown on Figure 2.17.

In terms of variability of rainfall in the European Community area, the greatest values are observed in the Mediterranean area based on long records from Marseilles, Milan and Rome, where the inter-annual variability reaches 40–50% during the Winter and 50–60% of the average during the Summer [Flohn, 1984].

2.2.2 United Kingdom

"The spatial distribution of precipitation in an individual month is very uneven, just as it is on an individual day". "It is therefore not surprising that patterns of temporal variation of rainfall are complex" [Wright, 1976].

Over the British Isles the highest average annual rainfall (more than 3200 mm) occurs generally in West and is more pronounced in the North-west with the lowest values (less than 800 mm) in central and East England and also on the East coast of Scotland (see Figure 2.18).

Spatial patterns of precipitation variability over the United Kingdom, emphasising England and Wales, were examined by Wigley, Lough and Jones (1984) using principal components analysis, in order to divide England and Wales into sub-regions of high spatial coherence. The results "suggest greater spatial variability of Summer precipitation in the more recent period" and at "large scale annual precipitation variations are dominated by the Winter". They defined five main regions (see Figure 2.6 (a)) of which the coherence of rainfall variations was checked by a cross-correlation between 5 stations with long record and the remaining stations (see Figure 2.19).

2.2.3 West of Scotland and Loch Lomond area

Scotland in general is identified as a country with a very high rainfall, but this is a characteristic only for the West part and not for the whole country, as is shown in Figure 2.18, which represents the long-term averages (1941–70) of rainfall calculated by the Meteorological Office. The marked spatial variation of rainfall over Scotland is also shown in

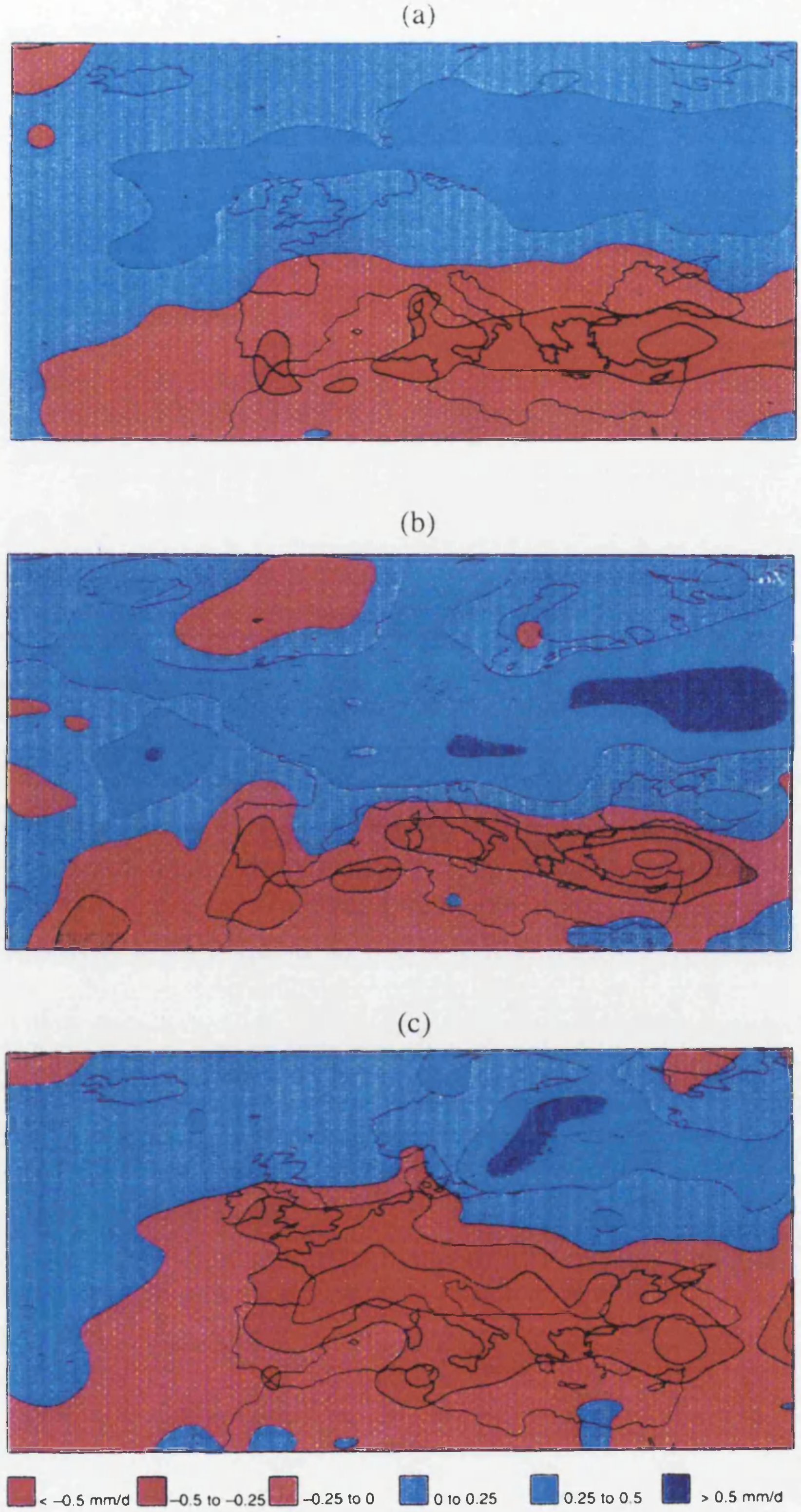

Figure 2.17: Changes in (a) annual, (b) Winter and (c) Summer precipitation over Western Europe, for the decade centred on the time of doubling of the atmospheric concentration of CO_2 — model years 66–75 [HCCPR, 1992].

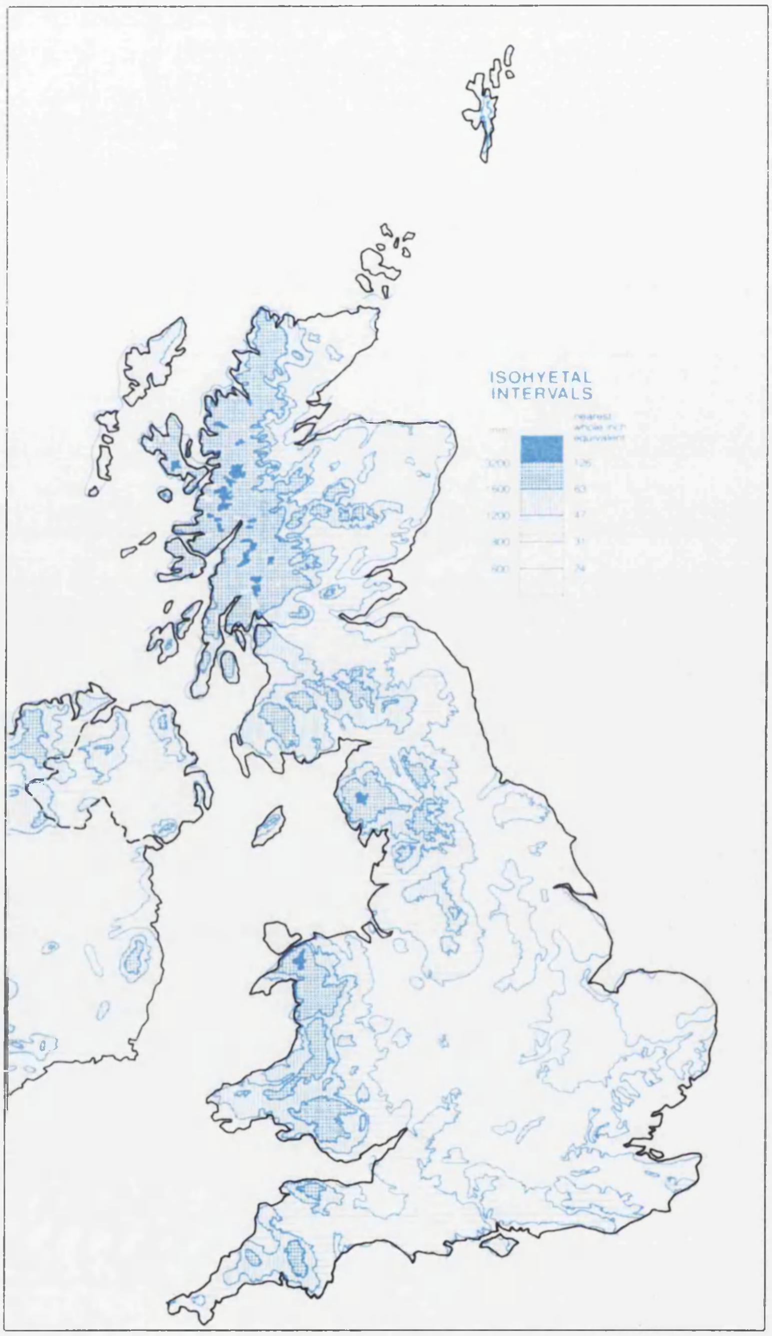

Figure 2.18: Average annual rainfall (1941–70) [MetOffice, 1989].

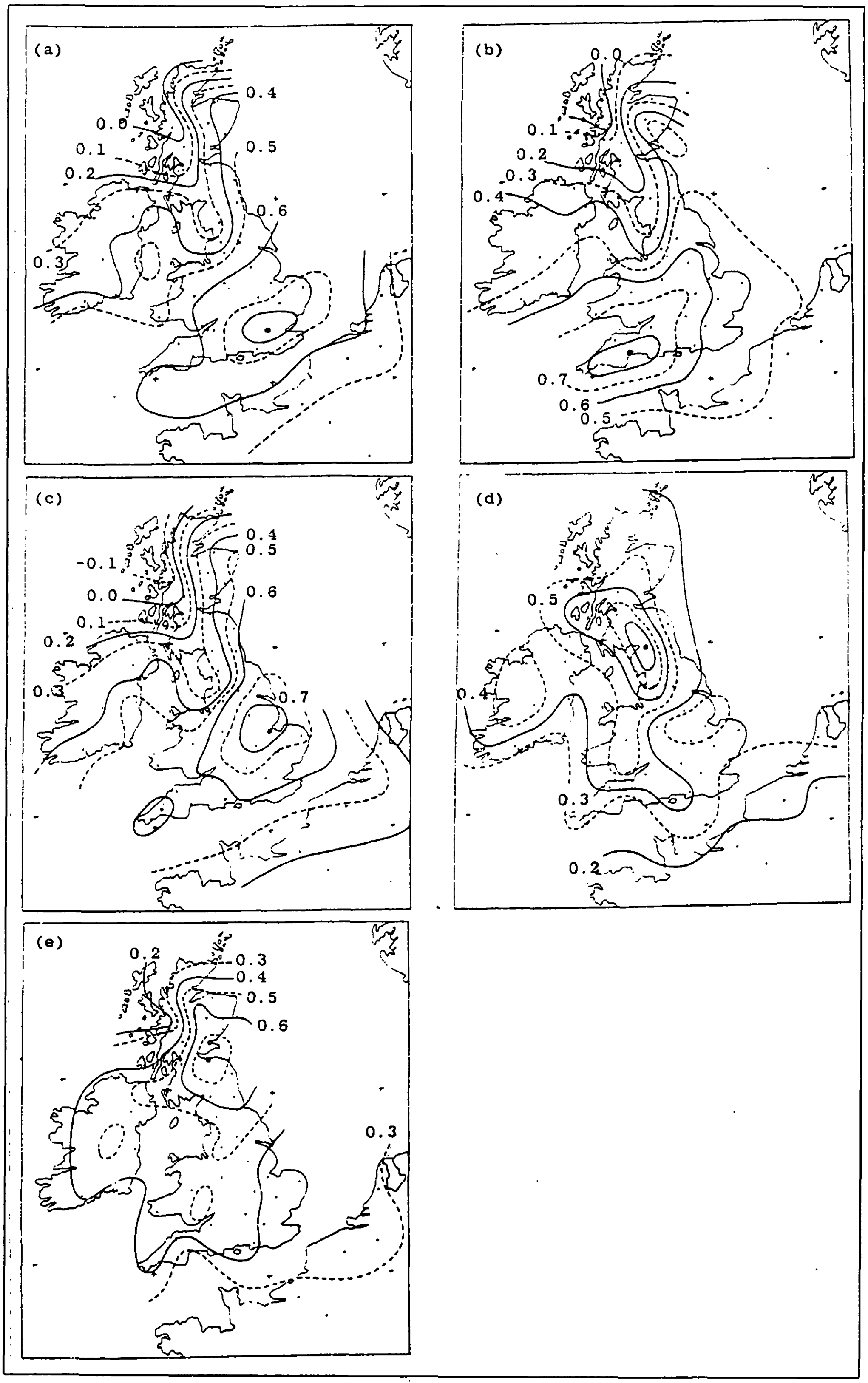

Figure 2.19: Spatial patterns of the correlations between annual precipitation at 55 stations and at (a) Kew, (b) Exeter, (c) Spalding, (d) Carlisle and (e) Edinburgh [Wigley *et al.*, 1984].

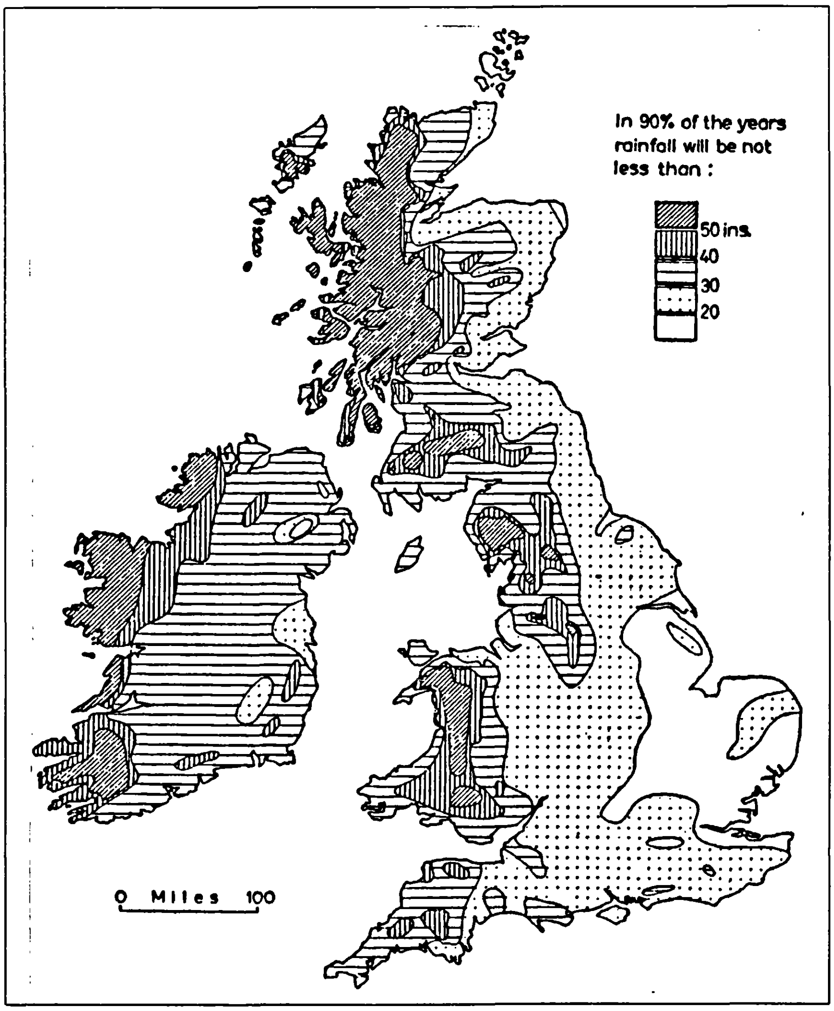

Figure 2.20: Rainfall probability of British Isles [Gregory, 1968].

terms of rainfall probability (see Figure 2.20). Annual rainfall variability, measured by the coefficient of variation, shows that the wet areas of the West coast have less variability, compared to the East coast. (see Figure 2.21).

For the Loch Lomond catchment area, the average annual rainfall (1941–70) [MetOffice, 1977] varies from more than 3600 mm on the slopes of Beinn Ime to less than 1300 mm between Drymen, Killearn and Balfron, in the Endrick basin. Curran and Poodle (1991) summarised the mean annual rainfall data from records of five daily rainfall stations with records from 1970s or 1980s. These indicate a variation from 3008 mm in the North part of the basin to 1372 mm in the South-east part [Curran and Poodle, 1991]. For summer half- year (April-September) the average rainfall (1941–70) varies between 1400 mm on the Northern mountains and 600 mm in the triangle between Drymen, Killearn and Balfron

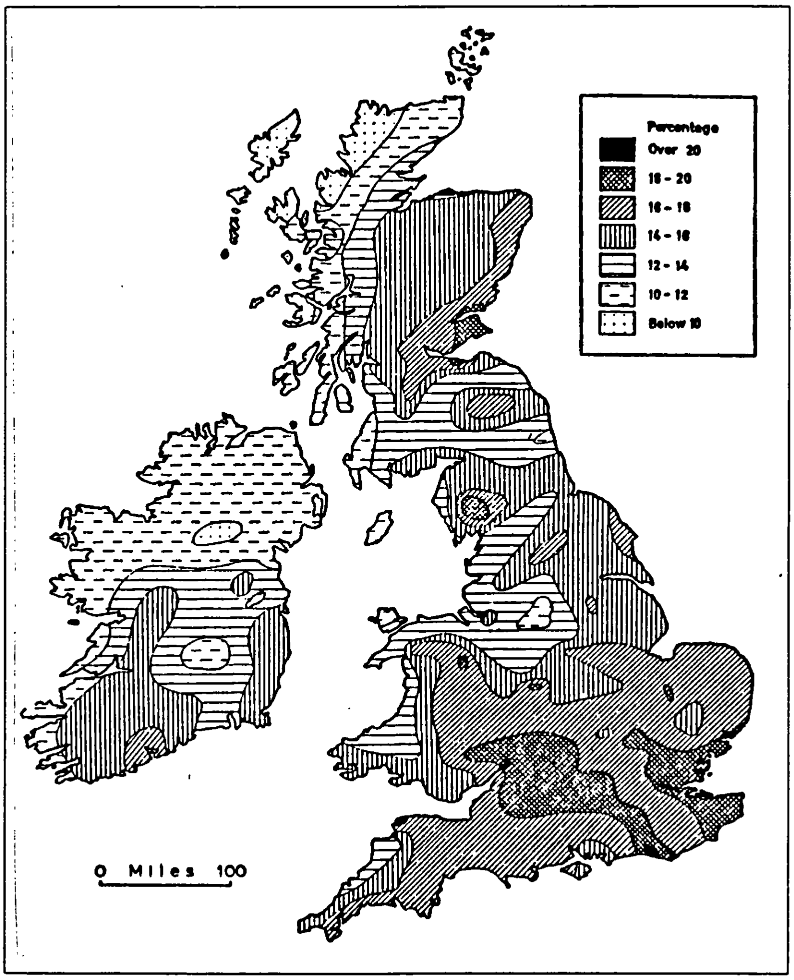

Figure 2.21: The coefficient of variation of annual rainfall over the British Isles, 1901–1930 [Gregory, 1968].

[MetOffice, 1979].

The map of average annual rainfall (1941–70) over the United Kingdom, at the scale of 1:625 000, published by the Meteorological Office is a good document to analyse spatial patterns of the rainfall. For a very specific catchment area, namely Loch Lomond basin, a more detailed representation is needed, however. Furthermore, in order to fully understand the identified increases in rainfall/streamflow, a detailed areal distribution of recent average rainfall is also needed. In the present study, isohyet maps of average annual rainfall are drawn for the Loch Lomond basin, for the standard periods 1916–50, 1941–70 and 1961–90, in order to identify spatial change in rainfall patterns over the Loch Lomond basin.

Chapter 3

Methods

In this chapter the ways in which the data were collected and the methods used in the analysis are introduced.

3.1 Terminology

Due to the natural variability of rainfall in time and space and the different ways in which this is expressed, the terminology used in the present study is clarified below.

Considering that rainfall is "the water equivalent of all forms of atmospheric precipitation received in a rain-gauge, assuming that there is no loss by evaporation, percolation or runoff" [Whittow, 1984] and our data were obtained by this process, in this study the word rainfall is used as synonymous with precipitation.

A rainfall station designates both a single station or groups of adjacent stations grouped in order to facilitate the description and analysis of the results.

The principal analysis in this study is to evaluate the rainfall variability in the Loch Lomond basin in time and space. Long-term variability is considered to occur when the data series has more than 60 years of measurements and short-term variability when the data series has less than 60 years of measurements.

The term "**climate change**" has a number of meanings and the rainfall, as a climatic element, is directly related to climatic variations. Thus, to characterise the rainfall in the study area, several concepts related to climatic variations are used.

Firstly it is essential to distinguish rainfall fluctuations from rainfall changes in time. In a set of rainfall data fluctuations (or variations) occur when the rainfall values oscillate through time. If these fluctuations have a certain rhythm, the rainfall has periodicity fluctuations, if not, it has aleatory fluctuations. A rainfall change is marked by a trend or a discontinuity in the time distribution [Oliver, 1981]. These definitions are in accordance with the Landsberg definitions (1975), cited by who considers climatic fluctuation as "a situation of temporary deflection which can revert to earlier conditions or which may even be followed by changes in the opposite direction [and] climatic change as involving a shift of climatic conditions to a new equilibrium position with values of climatic elements also changing significantly" [Olaniran, 1991]. Peixoto further considers that climatic changes are "significative variations for longer time periods to which could be given a defined cause" [Peixoto, 1987].

Climatic variability is concerned with variations or anomalies, but over short periods of time, this mainly relates to interannual variability including "extreme values and the differences between annual, seasonal or monthly mean values and the corresponding expectable values" [Peixoto, 1987]. Nevertheless, there is also variability on longer time-scales, which could be periodic, quasi-periodic and non-periodic, because of the interannual variability. The reliability of rainfall is expressed either as a mean or as an extreme percentage departure from the normal" [Jones *et al.*, 1990].

Variability of rainfall could be markedly affected by the variability on a time scale of months to seasons. Because of this it is essential to analyse the monthly and seasonal variability, as well as annual variability. In the present study, the annual rainfall from October to September, and the seasonal rainfall for Winter half-year (from October to March) and Summer half-year (from April to September) are considered.

3.2 Selecting and grouping rainfall stations

The rainfall stations used in the present study were selected from the Meteorological Office network of stations (see Table 3.1). In order to establish trends in rainfall patterns in the Loch Lomond basin, the selection of stations in the catchment area was based on gathering a wide spatial sample of the area (Figure 3.1) and on the range of rainfall data available (Table 3.2). In Table 3.2 it is evident that there are great differences between the range of recorded years for the stations in the area, and this was a problem when selecting the stations. In order to obtain longer series of data, adjacent stations were grouped.

However this procedure may involve the introduction of artificial trends or fluctuations. To minimise this possible problem, after grouping of stations, the homogeneity of the obtained series was tested. This is described below.

In the process of selecting the stations, priority was given to those with records in the last three decades in order to determine the short-term variability (trend) in the study area. The proximity between stations was also considered in order to obtain continuity of records until the present. The final groups of stations are presented as Roman numerals I-XIV in Table 3.1, which also contains information about rainfall stations, Stronachalachar, Helensburgh and Glasgow Airport (see Figure 3.1), which are located outside of the Loch Lomond basin. These stations were used in this study as control stations, in order to compare trends (fluctuations) and to complete some series with missing data by rainfall data estimation from the surface records. The choice of Helensburgh in particular, is justified by its long range of data (since 1871) and its location close to the southern part of the Loch Lomond catchment area[1].

3.3 Rainfall data

The monthly and annual (calendar year) rainfall values for the selected stations were supplied by the Meteorological Office — Past Weather Advice in Edinburgh. The rainfall averages for the periods 1916–50, 1941–70 and 1961–90, for the stations in the area, were also supplied by the Meteorological Office. The precise location and altitudes of the rainfall stations are presented in Table 3.1, together with start and end dates.

After 1960 the data are available by year in millimetres. Before 1960 the data are available by station only in inches, except for Helensburgh and Abbotsinch, for which data are already provided in millimetres. As a result, the first step in the data preparation was to convert the data from inches to millimetres.

3.3.1 Missing data

During the preparation of the data, several missing values, sometimes for more than one year, were identified, producing gaps in the time series. The complete set of data is

[1]Blanefield also has a long range of data and lies inside the Loch Lomond basin but, because its records are affected by the proximity to the hills of Campsie Fells, priority was given to Helensburgh.

Code RSTNNO	Selected Stations	St. No	St. Name (site)	Location (NGR) East	Location (NGR) North	Altitude (m)	Records on rainfall first year	Records on rainfall last year
661562		1	Keilator	2368	7244	229	1969	1982
661777		2	Allt Nan Caorrunn	2278	7222	366	1954	1967
661778	I	3	Allt Nan Caorrunn	2277	7220	341	1967	1992
661807	I	4	Dubh Eas	2291	7203	369	1948	1967
661882	II	5	Lairig, Arnan	2295	7181	340	1948	1959
661883	II	6	Lairig, Arnan	2295	7182	340	1957	1992
661901		7	Inverarnan	2317	7185	18	1968	1981
661912		8	Dubh Uisge	2285	7152	323	1960	1965
662014		9	Ardvorlich	2315	7116	342	1946	1978
662041	III	10	Sloy Power Sta. No.1	2324	7099	12	1946	1971
662042	III	11	Sloy Power Sta. No.2	2321	7098	12	1970	1992
662043		12	Sloy Power Sta. Mter.	2321	7098	12	1977	1986
662065		13	Loch Sloy, Cam Allt	2266	7143	482	1954	1959
662077		14	Allt A'Chnoic	2255	7140	411	1948	1992
662118		15	Sloy Main Adit	2293	7105	204	1957	1992
662119		16	Sloy Main Adit	2293	7104	204	1969	1992
662130		17	Beinn Ime, South	2270	7080	381	1957	1992
662131		18	Beinn Ime, South	2270	7082	403	1946	1961
662142		19	Beinn Ime, North	2266	7093	467	1946	1969
662163		20	Coiregrogain	2300	7093	137	1946	1959
662173		21	Inveruglas	2320	7091	13	1984	1992
662208		22	Corriearklet	2382	7099	290	1905	1980
662214	IV	23	Corriehichan	2376	7085	198	1962	1992
662216	IV	24	Loch Arklet, Corriehichan	2372	7084	265	1905	1980
662239	IV	25	Corriehichan	2371	7084	265	1959	1962
662343		26	Rowchoish	2343	7050	168	1970	1981
662454		27	Ardess	2360	6994	18	1961	1984
662484		28	Glen Douglas	2276	6999	146	1980	1986
662549	V	29	Doune	2313	6981	98	1961	1992
662588	V	30	Inverbeg	2344	6981	46	1970	1985
662838	VI	31	Sallochy	2387	6955	47	1961	1978
662851		32	Cashell Burn	2418	6954	334	1961	1982
662984	VII	33	Arrochymore	2415	6918	30	1970	1992
662985		34	Arrochymore Logger Sta.	2413	6918	30	1990	1992
663046	VIII	35	Glen Finlas Resr. South	2329	6893	221	1972	1985
663047		36	Glen Finlas Resr. No.1	2328	6883	238	1911	1962
663048	VIII	37	Glen Finlas Resr. No.2	2330	6895	247	1911	1966
663121		38	Auchengaich Resr, North	2276	6918	244	1948	1985
663124		39	Auchengaich Resr, South	2275	6915	244	1948	1967
663174		40	Ballevoulin	2295	6885	137	1961	1981
663180		41	Blairnairn No.3	2308	6894	482	1933	1961
663181		42	Blairnairn No.2	2308	6888	381	1933	1961
663182	IX	43	Blairnairn No.1	2302	6882	175	1933	1992
663366		44	Endrick Weir	2682	5867	238	1952	1983
663433		45	Lurg Forest	2627	6846	305	1977	1978
663462		46	Fintry	2616	6870	91	1930	1968
663569		47	Mount Farm	2586	6873	107	1977	1978
663632	X	48	Old Ballikinrain	2559	6879	65	1948	1967
663672	X	49	Balfron High Sch.	2549	6891	104	1933	1951
663675	X	50	Balfron, Old Stables	2541	6886	53	1981	1992
663688	X	51	Balfron, the Old Manse	2542	6890	82	1968	1981
663703		52	Killearn,the Oaks	2522	6862	76	1930	1950
663787		53	Blanefield	2555	6796	76	1898	1992
663840		54	Quinloch Farm	2518	6820	30	1973	1992
663867		55	Killearn S. Wks	2518	6844	23	1973	1992
663913		56	Killearn Hosp.	2509	6850	23	1962	1971
663926		57	Burncrooks Resr	2490	6796	251	1967	1992
663931		58	Burncrooks Res.	2483	6795	252	1908	1967
664010		59	Drymen, Muir Park	2488	6919	201	1961	1980
664141		60	Drymen, Park of Drumq.	2483	6869	20	1937	1950
664254		61	Gartocharn	2425	6857	45	1961	1964
664462	XI	62	Loch Lomond Park	2391	6832	56	1961	1992
664469	XI	63	Loch Lomond Park	2391	6831	48	1922	1960
664585		64	Renton, Carman Filters	2383	6788	89	1901	1966
664975	XII	65	Helensburgh	2303	6837	96	1970	1992
664976	XII	66	Helensburgh	2303	6836	89	1871	1969
659049	XIII	67	Renfrew, Met. Office	2508	6663	8	1920	1966
660285	XIII	68	Abbotsinch, Met. Office	2480	6667	5	1066	1992
881872		69	Upper Glengyle	2361	7148	229	1914	1960
891909		70	Glengyle	2388	7133	119	1956	1992
891986	XIV	71	Stronachlachar	2401	7103	117	1956	1992
891990	XIV	72	Stronachlachar, Invergyle	2401	7103	115	1914	1958

Table 3.1: Characteristics of the rainfall stations used.

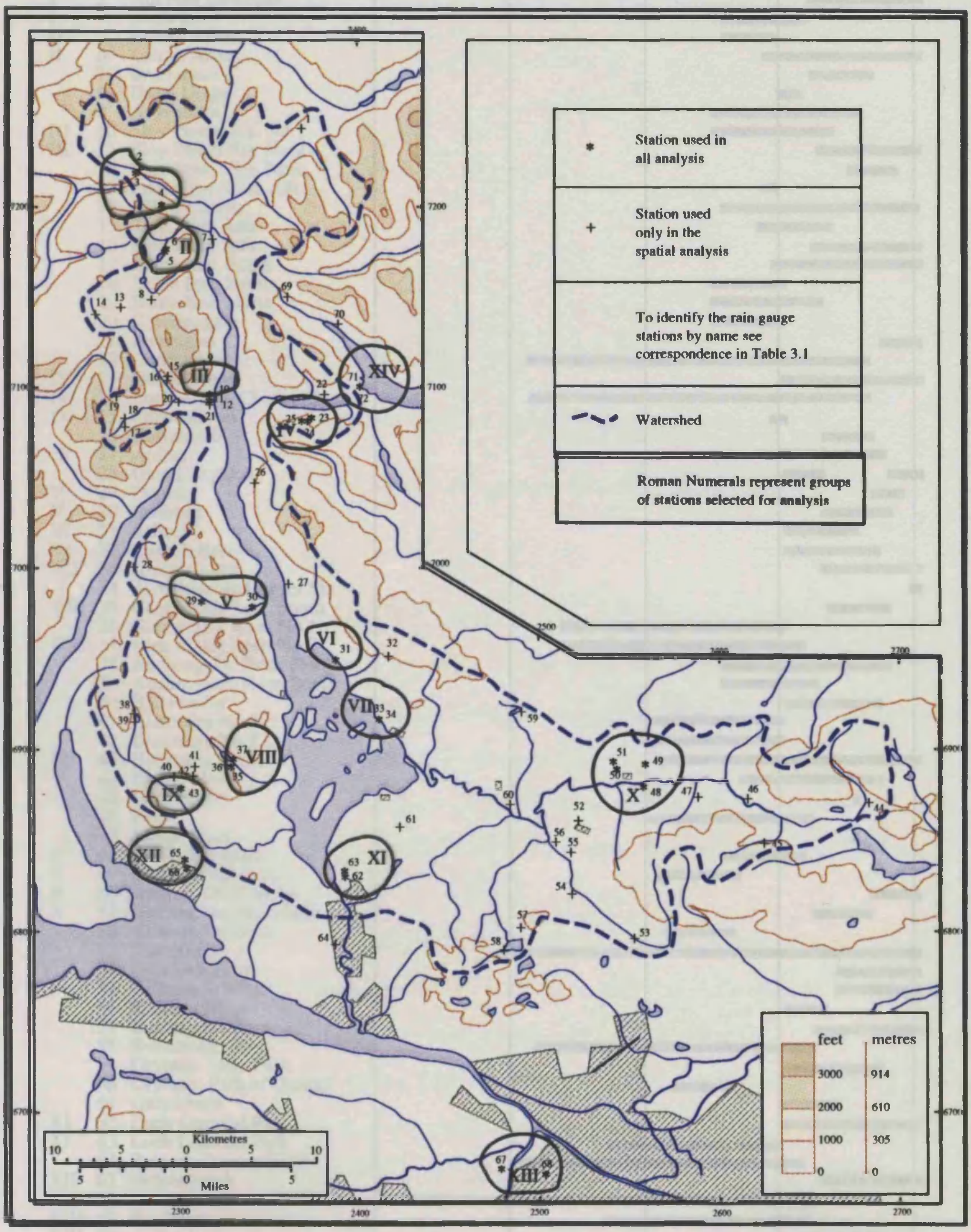

Figure 3.1: Sites of rainfall stations used in the present study.

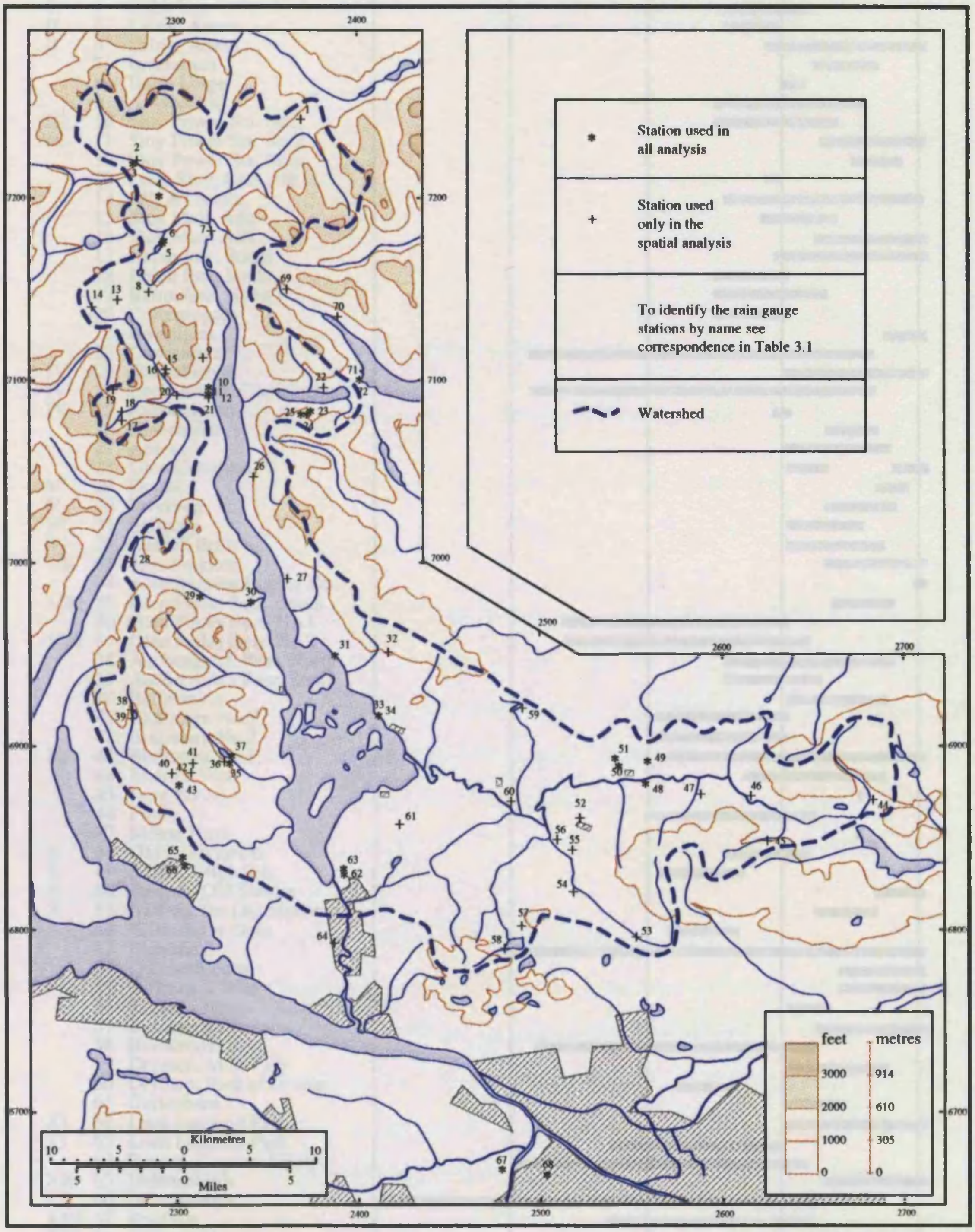

Figure 3.1: Sites of rainfall stations used in the present study.

		Station
	1	Keilator
	2	Allt Nan Caorrunn
I	3	Allt Nan Caorrunn
I	4	Dubh Eas
II	5	Lairig, Arnan
II	6	Lairig, Arnan
	7	Inverarnan
	8	Dubh Uisge
	9	Ardvorlich
III	10	Sloy Power Sta. No.1
III	11	Sloy Power Sta. No.2
	12	Sloy Power Sta. Mter.
	13	Loch Sloy, Cam Allt
	14	Allt A'Chnoic
	15	Sloy Main Adit
	16	Sloy Main Adit
	17	Beinn Ime, South
	18	Beinn Ime, South
	19	Beinn Ime, North
	20	Coiregrogain
	21	Inveruglas
	22	Corriearklet
IV	23	Corriehichan
IV	24	Loch Arklet, Corriehichan
IV	25	Corriehichan
	26	Rowchoish
	27	Ardess
	28	Glen Doughlas
V	29	Doune
V	30	Inverbeg
VI	31	Sallochy
VI	32	Cashell Burn
VII	33	Arrochymore
	34	Arrochymore Logger Sta.
VIII	35	Glen Finlas Resr. South
	36	Glen Finlas Resr. No.1
VIII	37	Glen Finlas Resr. No.2
	38	Auchengaich Resr, North
	39	Auchengaich Resr, South
	40	Ballevoulin
	41	Blairnairn No.3
	42	Blairnairn No.2
IX	43	Blairnairn No.1
	44	Endrick Weir
	45	Lurg Forest
	46	Fintry
	47	Mount Farm
X	48	Old Ballikinrain
X	49	Balfron High Sch.
X	50	Balfron, Old Stables
X	51	Balfron, the Old Manse
	52	Killearn,the Oaks
	53	Blanefield
	54	Quinloch Farm
	55	Killearn S. Wks
	56	Killearn Hosp.
	57	Burncrooks Resr
	58	Burncrooks Res.
	59	Drymen, Muir Park
	60	Drymen, Park of Drumq.
	61	Gartocharn
XI	62	Loch Lomond Park
XI	63	Loch Lomond Park
	64	Renton, Carman Filters
XII	65	Helensburgh
XII	66	Helensburgh
XIII	67	Renfrew
XIII	68	Abbotsinch
	69	Upper Glengyle
	70	Glengyle
XIV	71	Stronachlachar
XIV	72	Stronachlachar, Invergyle

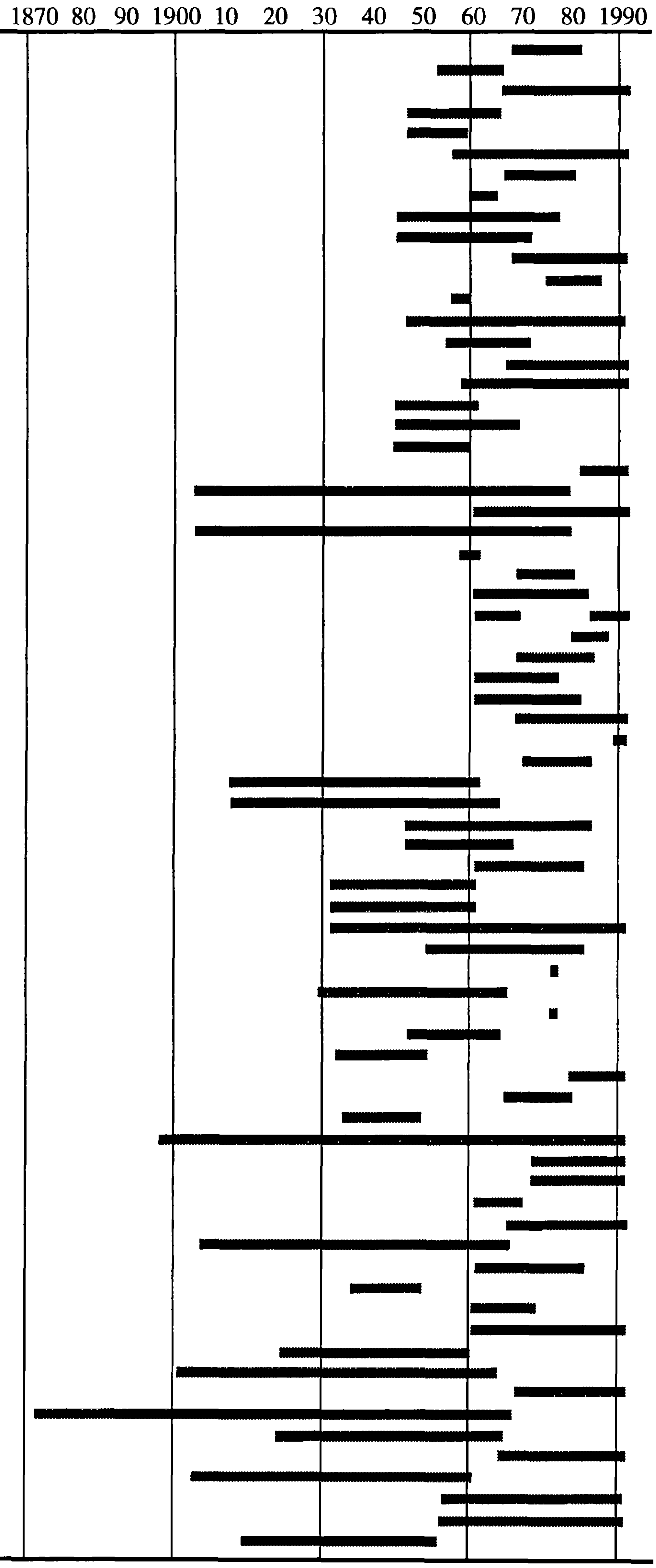

Table 3.2: Years of recorded rainfall for the stations in the study area.

presented in Appendix A. Because these gaps are inconvenient in the analysis, monthly missing values were estimated in order to fill the gaps. Several methods of estimating gaps in climate data are available, the most appropriate of which is an average of ratios in a parallel estimation [Hjelmfelt, 1975], using the formula:

$$\frac{P_x}{\overline{P}_x} = \frac{1}{N}\sum_{i=1}^{N}\frac{P_i}{\overline{P}_i} \tag{3.1}$$

where:

P_x = unknown value

$\overline{P}_x$ = average annual catch at station with missing data

N = number of surrounding stations used to estimate missing value

P_i = catch for the same time period as the missing value but at station i

$\overline{P}_i$ = average annual catch at station i

In spite of the fact that all methods may be equally valid [Linacre, 1992], the described method provides both accuracy and is easier to use than, for example, interpolation from both a smooth curve on a graph of measurements or an isohyetal map, where estimation is more subjective. On the other hand climatological estimation, where "a missing daily value equals the average of measurements taken at the same time in other years" [Linacre, 1992] was not used because only monthly and annual data were collected for the purpose of the present study.

In estimation of data, errors (difference from measurements) are inevitable. These errors may be caused by "untrue assumptions implicit in the adopted method of estimation, e.g. a wrong choice of proxy or an invalid assumption of homogeneity [...] the independent variable contain measurements errors [...] the equation may involve averaged measurements of factors which are not independent" [Linacre, 1992]. It is possible to calculate errors in the estimation by using the difference between measurements and estimated values. This procedure was done for all months of one randomly chosen year for each station with missing data. The result of this test is presented in Table 3.3. This table shows the errors for each month and the annual mean of errors to be very low (2.1mm/year). This simple test is a clear indication of the formula accuracy.

St.	Used St.	Year		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	mean
I	VII	1981/82	K	330.0	484.0	113.0	321.8	260.3	258.0	76.0	159.2	78.4	60.0	306.9	504.8	
			E	401.1	393.2	109.1	232.2	198.9	319.4	96.9	147.1	130.6	52.3	269.4	382.5	
			K-E	-71.1	90.8	3.9	89.6	61.4	-61.4	-20.9	12.1	-52.2	7.7	37.5	122.3	18.3
II	IX,XII	1988/89	K	356.6	163.5	477.0	733.5	674.1	435.9	91.5	75.2	138.3	92.6	502.3	226.1	
			E	469.9	305.8	376.9	447.9	481.9	502.3	127.8	94.9	146.6	104.2	380.5	303.0	
			K-E	-113.3	-142.3	100.1	285.6	192.2	-66.4	-36.3	-19.7	-8.3	-11.6	121.8	-76.9	18.8
III	IV, XIV	1966/67	K	143.0	255.0	413.5	269.5	274.3	526.5	159.3	214.1	152.7	225.8	116.3	260.9	
			E	180.0	221.7	406.6	280.4	293.2	490.8	128.5	234.6	141.5	206.5	119.1	298.0	
			K-E	-37.0	33.3	6.9	-10.9	-18.9	35.7	30.8	-20.5	11.2	19.3	-2.8	-37.1	
IV	XII	1986/87	K	300.0	487.0	625.0	110.0	149.0	219.0	72.0	79.0	106.0	89.0	170.0	272.0	
			E	297.4	496.2	529.1	159.4	225.6	323.8	86.6	112.1	140.7	129.5	235.5	255.4	
			K-E	2.6	-9.2	95.9	-49.4	-76.6	-104.8	-14.6	-33.1	-34.7	-40.5	-65.5	16.6	-26.1
V	III, XIV	1976/77	K	254.4	256.2	109.5	151.8	244.3	254.8	160.4	70.4	55.4	100.2	118.8	288.1	
			E	289.9	268.8	121.8	162.1	194.1	328.6	166.5	92.8	43.6	83.3	107.5	338.5	
			K-E	-35.5	-12.6	-12.3	-10.3	50.2	-73.8	-6.1	-22.4	11.8	16.9	11.3	-50.4	-11.1
VI	XIV,IV	1972/73	K	107.8	248.7	248.6	174.2	158.5	94.7	71.2	121.2	161.5	76.2	125.2	120.2	
			E	96.4	228.3	199.7	174.5	149.7	99.2	70.7	163.5	170.1	71.3	127.1	139.8	
			K-E	11.4	20.4	48.9	-0.3	8.8	-4.5	0.5	-42.3	-8.6	4.9	-1.9	-19.6	1.5
VIII	V,VI	1974/75	K	97.5	283.1	519.9	406.2	134.1	58.3	129.8	50.0	97.6	191.7	90.6	264.3	
			E	73.7	270.4	444.8	423.1	101.6	62.8	106.7	29.1	87.8	225.0	84.1	280.7	
			K-E	23.8	12.7	75.1	-16.9	32.5	-4.5	23.1	20.9	9.8	-33.3	6.5	-16.4	11.1
IX	VII, XII	1982/83	K	207.0	240.0	248.0	290.0	56.0	214.0	75.0	180.0	113.0	36.0	52.0	284.0	
			E	214.1	270.3	262.8	319.6	58.8	197.0	91.6	125.0	85.6	38.9	47.2	302.1	
			K-E	-7.1	-30.3	-14.8	-29.6	-2.8	17.0	-16.6	55.0	27.4	-2.9	4.8	-18.1	-1.5
XI	XII, XIII	1965/66	K	199.4	65.3	186.9	87.1	166.9	131.3	104.4	111.0	138.7	58.4	80.0	134.9	
			E	166.6	57.1	169.8	83.8	152.5	121.9	96.5	108.7	155.0	45.0	118.2	153.4	
			K-E	32.8	8.2	17.1	3.3	14.4	9.4	7.9	2.3	-16.3	13.4	-38.2	-18.5	3.0
XII	X, XIII	1956/57	K	113.0	70.0	190.0	198.0	109.0	169.0	70.0	73.0	65.0	172.0	114.0	80.0	
			E	98.0	39.8	167.4	189.6	116.3	131.2	62.0	78.8	54.7	109.1	121.6	76.7	
			K-E	15.0	30.2	22.6	8.4	-7.3	37.8	8.0	-5.8	10.3	62.9	-7.6	3.3	14.8
X	XII, XII	1963/64	K	126.2	199.9	51.1	61.2	43.5	67.1	91.2	97.0	88.2	65.7	129.1	149.2	
			E	135.6	178.3	46.2	57.1	32.1	64.4	102.9	99.1	89.7	69.8	142.9	142.6	
			K-E	-9.4	21.6	4.9	4.1	11.4	2.7	-11.7	-2.1	-1.5	-4.1	-13.8	6.6	0.7
XIV	II, IV	1983/84	K	466.0	73.0	358.2	352.3	168.5	86.8	84.5	23.2	91.6	45.2	71.1	225.8	
			E	529.7	86.2	298.2	375.3	193.9	90.2	84.0	13.8	99.2	51.0	90.6	196.9	
			K-E	-63.7	-13.2	60.0	-23.0	-25.4	-3.4	0.5	9.4	-7.6	-5.8	-19.5	28.9	-5.2
									Mean of the errors in the estimation:							**2.1**

K = Known values E = Estimated values K-E = Difference between known and estimated values

Table 3.3: Errors in the monthly rainfall (mm) estimation.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
I	1													
II	0.81	1												
III	0.90	0.94	1											
IV	0.81	0.95	0.96	1										
V	0.90	0.82	0.94	0.87	1									
VI	0.72	0.84	**0.77**	0.88	**0.70**	1								
VII	0.83	0.63	0.82	0.81	0.86	**0.72**	1							
VIII	0.84	0.77	0.89	0.73	0.86	**0.78**	**0.60**	1						
IX	0.70	0.71	0.76	0.77	0.79	0.76	0.93	0.73	1					
X	0.78	0.71	0.84	0.73	0.84	**0.69**	0.92	0.74	0.79	1				
XI	0.78	0.87	0.91	0.83	0.82	**0.87**	0.94	0.73	0.84	0.86	1			
XII	0.86	0.77	0.91	0.81	0.95	**0.78**	0.90	0.78	0.78	0.86	0.91	1		
XIII	0.73	0.80	0.87	0.79	0.84	**0.88**	0.94	0.69	0.82	0.79	0.91	0.92	1	
XIV	0.80	0.93	0.95	0.89	0.91	0.90	0.76	0.73	0.72	0.73	0.86	0.84	0.81	1

Table 3.4: Correlation matrix of chosen stations.

In order to select stations to be used in the estimation, the degree of similarity of any pair of data was quantified by its correlation coefficient. An high correlation coefficient between data series is an indication that the two correlation stations have similar monthly rainfall amounts. Each correlation value, $\rho_{X,Y}$ between the series X and the series Y, is calculated using the formula:

$$\rho_{X,Y} = \frac{Cov(X,Y)}{\sigma_X \sigma_Y} \tag{3.2}$$

Where,

$$\sigma_X^2 = \frac{1}{N}\sum_{i=1}^{N}(X_i - \mu_X)^2 \tag{3.3}$$

and

$$Cov(X,Y) = \frac{1}{N}\sum_{i=1}^{N}(X_i - \mu_X)(Y_i - \mu_Y) \tag{3.4}$$

The similarity between the series X and the series Y increases with the value of $\rho_{X,Y}$ and is maximal for 1. A correlation matrix with the correlation coefficient for all the studied series was constructed and is presented in Table 3.4. Correlation values with less than 99% of significance, using the student's t test [Gregory, 1968], are distinguished in bold. Preference was given to stations with high correlation coefficient

The selection of stations to use in the estimation is based on the correlation matrix, the station altitude (see Table 3.1), its latitude (see Figure 3.1) and the monthly rainfall average of all the stations (see Appendix A). In some cases values of series with weaker correlations were used (e.g., 0.79, 0.78, 0.76, 0.74, 0.73, 0.71) due to the absence of data in the same month; a prominent example is December of 1985 when only 5 of the 14 series have the respective rainfall record.

Table 3.5, 3.6 and 3.7 shows all the estimated values and indicates the stations for which monthly rainfall values were used in the calculations. Nevertheless, the Helensburgh series still has a gap in 1900 and 1901. Whenever possible, two adjacent stations were chosen in order to obtain better estimations.

The complete time series, including the grouped stations and the estimated values, are presented in the Appendix A. These time series are arranged in tables and ordered by the hydrometeorological year, which begins on October. Consequently the annual values are in accordance with this ordering. All the calculations, graphic and map representations presented later are based on these time series by hydrometeorological year, or on the rainfall 30 years averages by calendar year, the last one of which has been provided by the Meteorological Office.

3.3.2 Data homogeneity

Because of these two major problems with the collected rainfall records, namely the different periods of records and missing data, and the need to group stations and estimate values, it is necessary to assess the homogeneity of the resultant data. This preliminary step is essential to test for changes in the data-set, since the process of estimating values and grouping stations may have introduced inconsistency in a series created from more than one population [Oliver, 1981].

Beyond the assessment of homogeneity of records, the objective is to establish the series homogeneity, or heterogeneity, after the inclusion of estimated values and the grouping of stations. Double-mass analysis was used, the technique consisting of the calculation of the cumulative rainfall for each one of the series and plotting it "against the combined cumulative catch of several surrounding rain gauges". If the resulting line in the graph is a straight line, a consistent series emerges but, if there are one or more substantial changes in slope, the series is not consistent [Hjelmfelt, 1975]. The result of double-mass

Station	Used St.	Year	Month	Estimate
I	VII	1985	Apr	238.8
			Jul	459.3
			Dec	559.8
II	XII, IX	1985	Dec	576.9
III	IV, XIV	1946	Jan	378.9
			Feb	190.2
			Mar	150.0
			Apr	95.5
			May	63.3
		1974	Jan	698.4
			Feb	268.8
			Mar	132.3
			Apr	12.5
			May	180.5
			Jun	92.8
			Jul	155.7
			Aug	188.2
			Sep	264.4
			Oct	79.0
			Nov	427.5
			Dec	593.7
		1984	May	22.0
		1985	Aug	412.0
	IV, VII		Nov	231.3
	VII, XII		Dec	487.3
IV	XIV, III	1984	Nov	380.2
	XII	1985	Dec	390.9
V	III, XIV	1964	Jan	130.3
			Feb	92.4
			Mar	120.4
			Apr	157.3
			May	224.6
			Jun	111.4
			Jul	165.3
			Aug	188.6
			Sep	225.6
			Oct	137.9
			Nov	239.4
			Dec	269.1
		1970	Mar	152.8
			Apr	137.7
			May	123.1
			Jun	103.4
			Jul	197.6
		1982	Nov	376.2
		1985	Apr	139.8
			May	103.2
			Jun	89.4
			Jul	262.8
	IV, XIV		Aug	421.2
	III, XIV		Sep	338.7
			Oct	220.5
	IV, VII		Nov	203.3
	VII		Dec	395.1
VI	XIV, IV	1979	Jan	150.2
			Feb	40.9
			Mar	247.3
			Apr	80.3
			May	91.8
			Jun	80.9
			Jul	76.7
			Aug	147.9
			Sep	229.9
VIII	V, VI	1962	Jan	360.7
			Feb	193.1
			Mar	47.6
			Apr	108.7
			May	90.1
			Jun	155.1
			Jul	177.4
			Aug	360.6
			Sep	276.0
VIII	V, VI	1962	Oct	114.5
			Nov	99.3
			Dec	272.4
		1963	Jan	20.8
			Feb	60.9
			Mar	287.3
			Apr	137.8
			May	195.1
			Jun	117.7
			Jul	188.6
			Aug	161.0
			Sep	156.6
			Oct	248.5
			Nov	256.7
			Dec	114.1
	IX, VI	1964	Jan	93.8
			Feb	47.1
			Mar	99.6
			Apr	208.4
			May	158.3
			Jun	114.6
			Jul	187.1
			Aug	223.4
			Sep	211.3
			Oct	143.6
			Nov	205.3
			Dec	234.1
	V, VI	1966	Jan	172.9
			Feb	215.5
			Mar	143.2
			Apr	146.5
			May	155.2
			Jun	179.5
			Jul	77.6
			Aug	142.3
			Sep	201.4
			Oct	133.4
			Nov	190.4
			Dec	384.7
		1967	Jan	206.0
			Feb	232.3
			Mar	259.8
			Apr	120.2
			May	172.5
			Jun	133.0
			Jul	239.8
			Aug	132.8
			Sep	215.7
			Oct	412.6
			Nov	130.3
			Dec	148.2
		1968	Jan	183.9
			Feb	86.2
			Mar	168.7
			Apr	92.3
			May	135.9
			Jun	68.9
			Jul	131.1
			Aug	148.1
			Sep	242.7
			Oct	361.9
			Nov	153.0
			Dec	60.4
		1969	Jan	192.3
			Feb	64.4
			Mar	31.4
			Apr	88.0
			May	128.7
			Jun	177.1
			Jul	128.6
			Aug	135.3
			Sep	158.2

Table 3.5: Estimated rainfall values (in mm) for stations I–VI and VIII.

Station	Used St.	Year	Month	Estimate
VIII	V, VI	1969	Oct	187.1
			Nov	215.4
			Dec	195.7
		1970	Jan	183.3
			Feb	187.4
			Mar	43.6
			Apr	77.3
			May	39.4
			Jun	64.4
			Jul	109.5
			Aug	156.0
			Sep	276.5
			Oct	276.8
			Nov	285.9
			Dec	142.9
		1971	Jan	240.7
			Feb	163.1
			Mar	74.1
			Apr	67.0
			May	95.5
			Jun	95.0
			Jul	119.1
			Aug	157.7
			Sep	66.3
			Oct	292.1
			Nov	144.4
			Dec	224.1
	X, IX	1985	May	87.7
	X, XI		Jun	100.3
	X, IX		Jul	328.4
			Aug	375.6
			Sep	380.1
IX	VII, XII	1985	Jun	83.5
XI	XII, XIII	1963	Sep	97.1
	X, VII	1977	Aug	96.6
		1984	Jul	16.7
	XII, VII	1985	Apr	115.4
			Aug	240.9
			Sep	264.4
			Dec	230.5
XII	IV	1909	Jan	139.8
			Feb	76.3
			Mar	31.6
			Apr	117.3
			May	87.6
			Jun	63.5
			Jul	97.5
			Aug	101.0
			Sep	58.0
			Oct	203.9
			Nov	95.0
			Dec	153.0
		1910	Feb	156.9
			Mar	96.2
			Apr	120.2
			May	60.5
			Jun	42.9
			Jul	143.7
			Aug	242.1
	X, XIII	1969	Oct	77.2
			Nov	176.5
			Dec	117.2
		1970	Jan	121.4
			Feb	135.2
			Mar	59.0
			Apr	97.1
			May	34.1
			Jun	74.8
			Jul	99.4
			Sep	142.8
		1972	Jan	138.3
			Feb	80.0
XII	X, XIII	1972	Mar	65.8
			Apr	115.0
			May	133.5
			Jun	120.8
			Jul	64.7
			Aug	51.1
			Sep	12.0
			Oct	36.7
			Nov	145.5
			Dec	150.8
		1973	Jan	125.6
			Feb	92.9
			Mar	62.4
			Apr	67.8
			May	103.5
			Jun	88.6
			Jul	88.1
			Aug	92.8
			Sep	86.5
			Oct	64.4
			Nov	131.1
			Dec	170.3
		1974	Jan	273.3
			Feb	104.4
			Mar	78.0
			Apr	9.5
			May	64.0
			Jun	50.2
			Jul	93.0
			Aug	94.9
			Sep	129.2
			Oct	39.6
			Nov	161.3
			Dec	228.4
		1975	Jan	271.7
			Feb	70.8
			Mar	35.4
			Apr	72.1
			May	21.7
			Jun	72.2
			Jul	70.9
			Aug	54.7
			Sep	197.1
			Oct	114.5
			Nov	141.4
			Dec	49.8
		1976	Jan	165.6
			Feb	96.9
			Mar	143.0
			Apr	56.7
			May	167.0
			Jun	57.4
			Jul	63.7
			Aug	18.3
			Sep	89.4
			Oct	160.3
			Nov	146.4
			Dec	98.5
		1977	Jan	88.9
			Feb	153.5
			Mar	154.3
			Apr	87.4
			May	52.8
			Jun	43.8
			Jul	59.6
			Aug	100.6
			Sep	157.4
			Oct	186.5
			Nov	172.6
			Dec	100.1
		1978	Jan	153.9
			Jul	72.8

Table 3.6: Estimated rainfall values (in mm) for stations VIII, IX, XI, XII.

Station	Used St.	Year	Month	Estimate	Station	Used St.	Year	Month	Estimate
XII	X	1980	Feb	101.9	X	XIII, XII	1967	Apr	46.4
			Mar	102.1				May	104.4
			Apr	7.1				Jun	50.0
			May	21.8				Jul	90.0
			Jun	106.1				Aug	62.6
			Jul	124.8				Sep	128.1
			Aug	152.2				Oct	261.0
			Sep	154.7				Nov	88.3
			Oct	140.5				Dec	74.8
			Nov	165.1			1981	Jul	94.6
			Dec	233.2				Aug	22.6
X	XIII, XII	1946	Jun	96.1				Sep	273.1
			Jul	97.4				Oct	190.0
			Aug	84.9				Nov	193.7
		1963	Sep	86.9				Dec	45.9
		1967	Feb	132.0	XIV	II, IV	1985	Nov	151.2
			Mar	138.1		VII, XII		Dec	392.0

Table 3.7: Estimated rainfall values (in mm) for stations VII and X.

analysis for selected stations after the inclusion of estimated values and station grouping is presented in Figure 3.2.

In analysing those graphs only the series I (Dubh Eas and Alt Nan Caorrunn) has lack of consistency in the data. In 1967 there is a small change in slope (signalled in Figure 3.2), which coincides exactly with the change of records from Dubh Eas to Alt Nan Caorrunn. Thereafter, it is not advisable to use the series of observed rainfall of these two stations together as statistically they are from two different populations. There are two ways of dealing with this: simply not to use that data in the final analysis or to adjust the observed values. Because it is important to use rainfall series from several parts of the catchment area and considering these two stations are located in Northwest of Loch Lomond, the observed data of Dubh Eas station was adjusted by multiplying them by the ratio of the slopes of the two line segments, in conformity with the formula proposed by A.T. Hjelmfelt:

$$P_a = \frac{m_a}{m_o} P_o \qquad (3.5)$$

in which:

P_a = adjusted precipitation

P_o = observed precipitation

m_a = slope of line to which records are adjusted

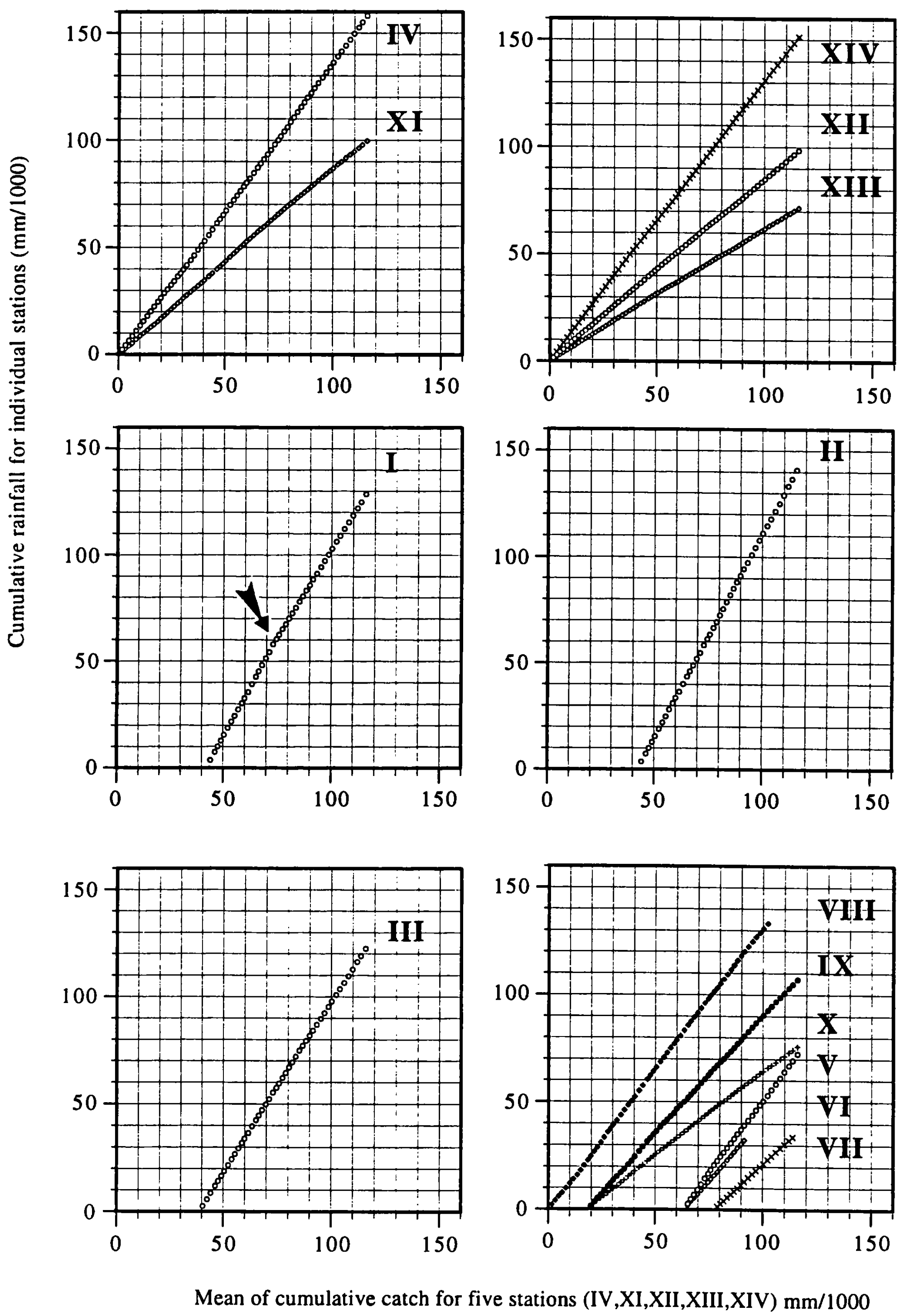

Figure 3.2: Double-mass analysis for the obtained annual series of rainfall.

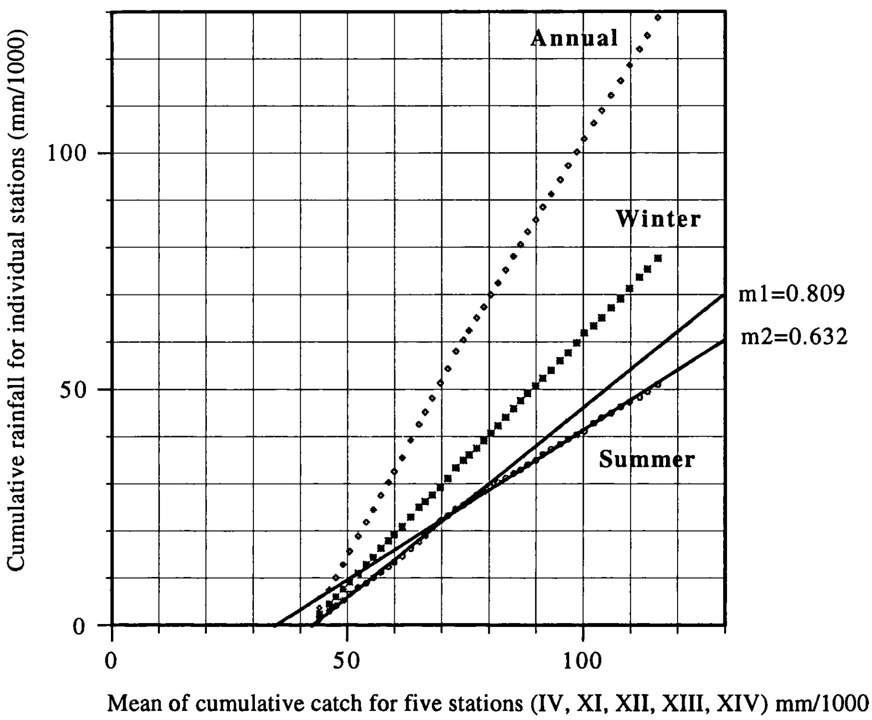

Figure 3.3: Double-mass analysis for station I.

m_o = slope of line at observed P_o

After careful observation of the contribution of the Summer half-year and Winter half-year cumulative catches for the total of station I (see Figure 3.3) only the Summer series shows signs of inconsistency. After the correction of the Summer values before 1967 using Equation 3.5, the final values are presented in Figure 3.4.

3.3.3 Final data series

In the last section it was demonstrated that by combining shorter, overlapping records from nearby stations, it is possible to compile a single homogeneous and complete record over a long period. After grouping records from nearby stations and estimating the missing data, a reasonable network of stations in the area was achieved (Figure 3.1). The shorter time series are for Sallochy (station VI) and Arrochymore (station VII) with 17 and 21 years of measurements respectively. Nevertheless, these series were included because of the site location in the central East side of the Loch. A better data series in the Loch Lomond basin, for Loch Arklet, Corriehichan station (station IV), has measurements from 1905 to present (87 years). Although this is a very good time series to analyse the long term

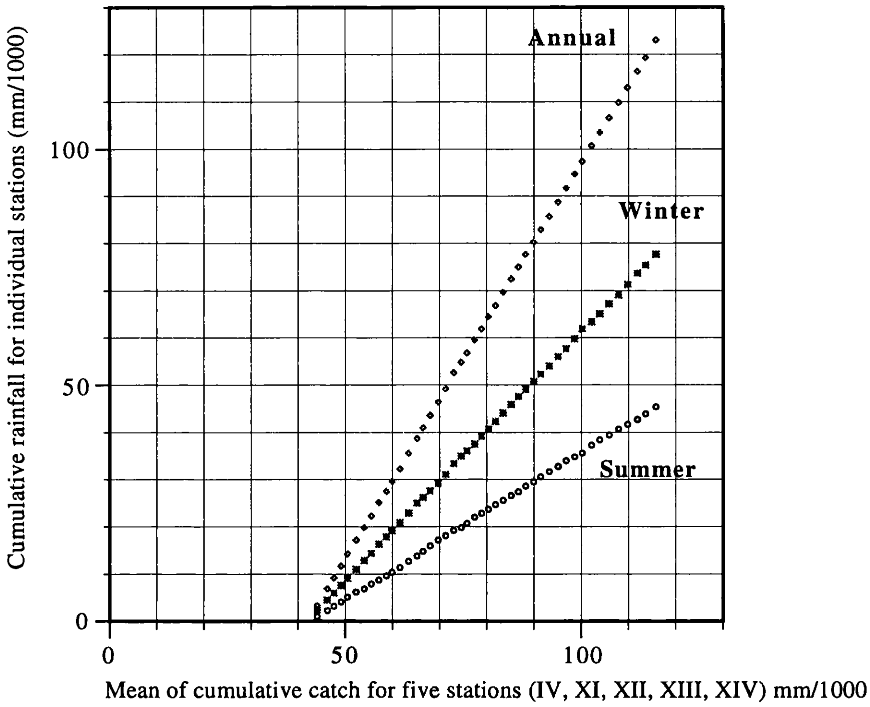

Figure 3.4: Double-mass analysis for station I with Summer values adjusted.

rainfall variability, it is only representative of the north part of the basin. Unfortunately, for the south part of the basin such a good time series does not exist. As a result the long data set (121 years) from 1871 to present for Helensburgh (station XII), was used for comparative purposes. This station is located in the Southwest part of the Loch Lomond but outside of its catchment area.

The annual rainfall amounts were calculated by hydrometeorological year. This is more convenient for climatological and hydrological studies and for management proposes of the area. As the management of the area is based essentially on the consequences of hydrological characteristics, the hydrometeorological year beginning in October was chosen. These rainfall totals are based on a "water-year" [Karl and Riebsame, 1989] which begins in October (after a general seasonal increase in precipitation over the study area) and finishes in September.

Most of the later analysis is based on the annual (October–September) and seasonal series, although monthly analysis is included. In the British Isles, to define seasonal periods over the year in order to identify seasonal trends and/or fluctuations is not easy, because the "British weather is so variable and the British seasons so uncertain, that one sometimes wonders whether or not Britain does have a climate" [Stringer, 1972]. Lamb (1954) however established "natural seasons" based on the weather patterns over Britain, during 50 years (1898–1947) despite of its lack of a "strongly defined character" [Lamb, 1964]. These 5 "natural seasons" are: early Winter (20/Nov.–19/Jan.); late Winter and early Spring (20/Jan.–31/Mar.); Spring and early Summer (1/Apr.–17/Jun.); high Summer (18/Jun.–9/Sep.) and Autumn (10/Sep.–19/Nov.). Nevertheless, Lamb (1954) concluded "that the natural seasons marked out by [...] the atmospheric circulation awkwardly fail to agree with any of the neat conventions for dividing the year up into four seasons of equal length". In spite of this, some authors in their climatological studies over middle and Northern latitudes, use these four astronomical, (or meteorological) seasons, Winter (Dec.– Feb.), Spring (Mar–May), Summer (Jun.–Aug.) and Autumn (Sep.–Nov.). The present study uses the "hydrometeorological seasons", Winter half- year (Oct.–Mar.) and Summer half-year (Apr.–Sep.). This decision was taken due to rainfall-runoff relationships (practical reasons) and for consistency with the use of the hydrometeorological year, which were presented above.

Thus, in order to obtain a series for the rainy and cold season (Winter half-year) and for the less rainy and warm season (Summer half-year), the sums of the monthly rainfall amounts of October to March and April to September, respectively, were calculated.

The final time-series analysis is based on the described series, annual (hydrometeorological year) and seasonal (Winter half-year and Summer half-year) for the 14 groups of selected stations, considering their different periods of measurements. Furthermore, the spatial analysis by isohyetal maps is based on conventional 30 years averages for a larger set of stations, whose locations are presented in Figure 3.1. Most of those averages were estimated by the Meteorological Office (Table 3.1). The method used for those estimations is concisely described by Shaw (1983), referring to the Hydrological Memoranda No. 5 from the Meteorological Office (1963).

3.4 Statistical methods used

In order to identify time and spatial changes in the rainfall of the study area, the prepared rainfall data were structured into different levels as follows:

- periodically (1916–50; 1941–70; 1961–90);
- annually (hydrometeorological year);
- seasonally (Winter half-year and Summer half-year);

Each one of these levels was analysed whenever possible with the appropriate statistical methods. The great part of the present study concentrates on the annual and seasonal analysis of the rainfall in the Loch Lomond basin. Thus, measures of central tendency and measures of dispersion were done for all annual, seasonal and monthly data sets. For the same levels a simple analysis of the frequency distribution was performed. The time series analysis was done on the annual levels, which includes both the periodic and seasonal levels. Although all the previous analysis has a spatial component in the Loch Lomond basin and the results are affected by this, a specific spatial analysis was performed for the periodic level.

3.4.1 Summary statistics

The first series of calculations include measures of central tendency, mean and median, in order to summarise the data by using a single value. These measures were used in the time series analysis (mean) and in the probability analysis (mean and median). Because the degree of accuracy of the mean has statistical but not physical meaning [Oliver, 1981] the standard deviation was also calculated, giving information about the distribution of the data around the mean. These measures together help in the analysis of the variability of the rainfall in the area. However, the variability is also evaluated with frequency analysis and time series analysis. These measures of central tendency and dispersion were calculated for the annual, seasonal and monthly series. The standard deviation (SD) was also used to divide the years and seasons into normal, rainy, extremely rainy, dry and extremely dry classes. A normal year is that which has rainfall amounts situated between mean-SD and mean+SD. Rainy, extremely rainy, dry and extremely dry years have, respectively, rainfall amounts situated between mean+SD and mean+3SD, beyond mean+3SD, between mean-SD and mean-3SD and beyond mean-3SD. This simple method together with a graphic representation gives a clear visualisation of the rainfall variability across the years with recorded data.

3.4.2 Frequency and variability analysis

The "frequency distribution is the basic tool for describing and analysing a population" [Oliver, 1981], and this was calculated for annual seasonal and monthly series, in order to facilitate estimates of probabilities. The variability of the rainfall in the Loch Lomond area was also expressed with the use of the median, upper (Q1) and lower (Q2) quartiles and the upper and lower extremes, which are plotted on graphs of monthly, seasonal and annual rainfall with the aim of facilitating the analysis of the results. In order to estimate the rainfall variability in the area, the coefficient of variation (CV) was used [Barry and Chorley, 1968].

3.4.3 Time-series analysis

Like other climatic elements, rainfall is concerned with changes in time and this requires a time-series analysis. Thus, the rainfall time-series analysis for the study area was performed for all the selected stations in order to characterise this phenomena over time and space. Considering that a "time-series is a series of data arranged chronologically, the data usually being equally spaced in time" [Stringer, 1972], the time series for annual and seasonal rainfall amounts was used. These data were plotted graphically for each year of the series and will be discussed below.

In spite of the fact that the ideal graphical representation of rainfall magnitudes related to periods of time, such as seasonal and annual, is by bar graphs, line graphs were used here in order to easily compare fluctuations and trends. Graphical representation of the time-series makes possible an analysis of various aspects of the rainfall behaviour such as "measurement of growth and decline; [...] identification of trends and fluctuations; [...] projections and predictions" [Hammond and McCullagh, 1978]. In such an analysis care must be taken because it is difficult to express the meaning of the changes in climatic elements (see section 3.1).

Due to the normally high interannual variability of precipitation, smoothing of data was introduced by calculating a 5 years moving average, or running mean, where each value is equal to the arithmetic averages of the last 5 successive terms in the series. However, the use of the moving average often eliminates from the time-series "the variations or 'cycles' whose period is the same as the period of the average". 5 years was chosen because "too much smoothing [...] will completely destroy the significant features of the curve" [Stringer, 1972]. Thus, a new series for annual and seasonal data were derived (Appendix B), which were plotted together with the raw data, in order to describe and compare long and short-term fluctuations and trends in the rainfall over the study area.

Other series were obtained by the calculation of the deviation of the actual values from the general mean, presented as a percentage of the mean per period of the series for convenience of interpretation. This deviation is given by:

$$\Delta_i = \frac{x_i - \mu_x}{\mu_x} 100 \qquad (3.6)$$

where:

Δ_i = deviation from the mean;

x_i = actual value; and

μ_x = mean over the total time-series

These deviations were plotted graphically in order to accomplish the analysis of the interannual variability.

The series of yearly and seasonal rainfall were also presented as linear trends, obtained by regression analysis using one equation of the form:

$$y = a_0 + a_1 x \qquad (3.7)$$

These trends "adequately reflect the relative magnitudes of the major rainfall epochs, without any presumption regarding their time distribution" [Rupa Kumar *et al.*, 1992].

For the major series (i.e. more than 60 years) — 5, 10, 11, 12, 14, 16, 20 and 21 — the presence or absence of a general trend was determined by using of Mann-Kendall rank statistics (test), recommended by the WMO (cited by [Carniel *et al.*, 1990]).

Using this methodology for analysing the time-series, it is possible to measure growth and decline, identify trends and fluctuations and attempt some projections and predictions of the rainfall in the study area. It is also possible, to establish the main differences in the rainfall behaviour in the various sections of the catchment area.

3.4.4 Spatial analysis

In this analysis, the main concern is with the distribution of rainfall within the Loch Lomond catchment area. Considering that rainfall is a phenomena greatly variable in time and space, the usual process of its observation is to measure it "at fixed points [...] at fixed times, and then to summarise statistically the resulting figures" [Stringer, 1972]. The resulting figures are maps of rainfall average distribution in the area, over different 35 or 30 years period. Such maps are called "climatological mean models" [Stringer, 1972], because the areal distribution of the climatological phenomena (rainfall, in this case) is "estimated from the observed data". Although it is "feasible to fit mathematical models to areal distributions" (for example averages of rainfall), this is possible "only in relatively flat areas", which is not the case of the study area (see Figure 3.1). Those areal models are often used in climatology and hydrology and have been empirically constructed as maps of isolines or isohyets, because "as soon as topography varies significantly and parameter isolines relatively closely follow topography, maps of empirical isolines of parameters [rainfall, in this case] necessarily replace mathematical models" [Yevjevich, 1993].

It is known that, in general, the precipitation increases with elevation (there is a direct relationship of precipitation to elevation) because "increased orographic uplift on windward slops enhances the likelihood of clouds dense enough for rain to form". [Linacre, 1992]. For example for Scotland at approximately 55^{o} of latitude, where the elevation rises from 9 to 333 metres, the gradient of the annual rainfall is 7% per 100 metres, according to Smithson (1969:372) cited by E. Linacre (1992). Because that increase "is primarily due to an intensification of the normal precipitation process and is not a special type" [Barry and Chorley, 1968], the construction of isohyetal maps in this dissertation have to take into account this effect.

Chapter 4

Rainfall in the Loch Lomond catchment area: long and short term variability

This chapter is concerned with reporting the rainfall data in the Loch Lomond catchment area and describing the results of the applied methodology.

Annual and seasonal rainfall amounts are described separately in different sections. In these sections summary statistics, frequency, probability, variability, fluctuations and trends of the rainfall are described for the selected rainfall stations, both inside and outside of the Loch Lomond basin. Three selected stations outside of the basin are used as control stations, the most important of these being Helensburgh which, because of its long term records, permits secular fluctuations and trends in the Loch Lomond area to be identified. The relationship between monthly, seasonal and annual rainfall amounts is also described in different sections.

Annual, seasonal and monthly rainfall amounts over the study area are analysed by hydrometeorological year (i.e. October to September). Some series included estimated values in the records gaps and the station group I (Allt Nan Caorrum and Dubh Eas) include adjusted values (see Appendices A and B).

For the temporal analysis the number of years studied are different since the data record for each station or group of stations is different.

The 30 years annual average rainfall in its spatial distribution over the study area is also described in the present chapter for three standard periods (1916–50; 1941–70 and 1961–90). In order to draw the isohyetal maps, the annual average rainfall available by calendar year, is used for the rainfall stations in the area and for each of the standard periods.

Possible future trends are inferred from the data presentation at the end of this chapter.

All the data series used in this chapter are presented in the Appendices A and B and the rainfall stations used in the analysis can be located using Figure 1.1.

4.1 Frequency, probability and variability

Measures of central tendency and dispersion, frequency, probability and variability of the rainfall, in the study area, are analysed in this section. Analyses were performed using annual, seasonal and monthly data for the selected stations.

4.1.1 Annual variability

The statistical properties of the annual rainfall series are summarised in Table 4.1 by each selected station (or group of stations). Despite variability in the data, the values presented characterise the general rainfall behaviour in the study area. Using the mean and median, and the location of the stations, it is noticeable that there is a general diminution in rainfall from Northwest to Southeast. This variation is very clear in Figure 4.1, which shows the quartiles, minimum and maximum rainfall values, with the stations ordered from North to South. Lairig (station II), in the Northwest part of the basin, has the greatest annual rainfall of between 2179 and 4340mm, in contrast with Balfron (station X), in the Southeast, which has the lowest annual rainfall between 978 and 1703mm. The figure shows stations close to one another with significant differences in terms of rainfall (comparing station III with IV, V with VI and VII with VIII).

From a short analysis of the annual rainfall frequency by normal, rainy and dry years, for the total number of variates at each station[1], it can be shown that the frequency distributions are close to a Gaussian distribution, with 68% of all observations between SD of the mean Table 4.2. This can be confirmed by the skewness coefficients (see Table 4.1),

[1]Stations VI and VII were not included because of the reduced number of variates.

stations	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
μ	2797	3202	2661	2256	2332	1796	1611	2102	1815	1285	1425	1352	1019	2156
SD	393	450	359	306	340	166	192	254	252	165	176	213	146	284
CV	14	14	13	14	15	9	12	12	14	13	12	16	14	13
skew	0.3	0.3	0.4	0.2	0.4	-0.4	0.1	0.5	0.3	0.4	0.5	0.2	0.3	0.3
min	2017	2179	1958	1453	1831	1437	1272	1595	1340	978	1083	882	668	1579
Q1	2503	2882	2419	2056	2073	1718	1499	1950	1643	1176	1297	1232	933	1959
Me	2750	3207	2671	2215	2334	1786	1565	2051	1802	1281	1404	1334	988	2137
Q2	3089	3510	2872	2448	2593	1948	1758	2273	2010	1380	1511	1501	1121	2320
max	3760	4340	3536	3063	3045	2050	1954	2833	2429	1703	1864	1952	1347	2898
N	44	44	46	87	31	18	21	67	59	59	70	119	72	77

μ	average	**Q1**	lower quartile (25%)
SD	standard deviation	**Me**	median (50%)
CV	coeficient of variation	**Q2**	upper quartile (75%)
skew	skewness indices	**max**	maximum value recorded
min	minimum value recorded	**N**	number of variates

Table 4.1: Summary statistics of annual rainfall amounts for the selected stations.

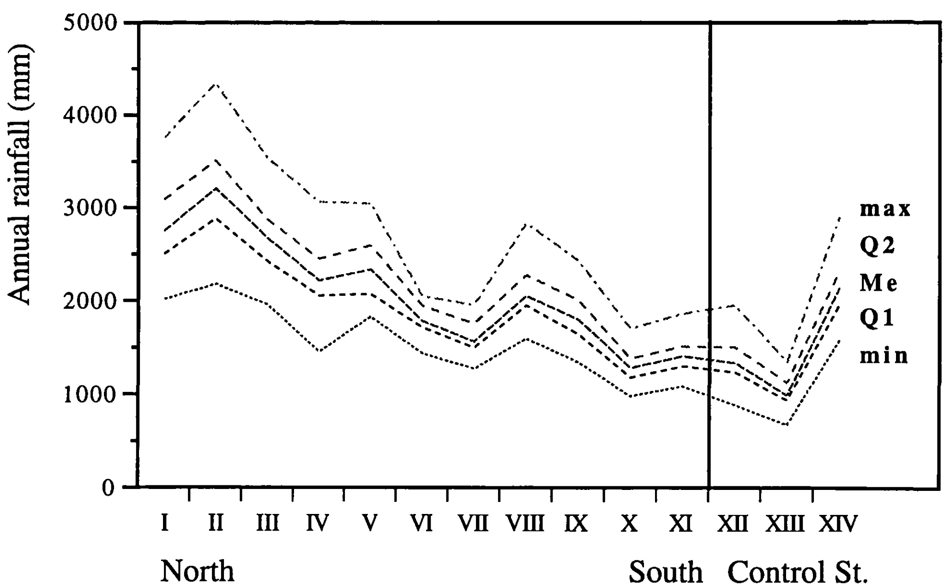

Figure 4.1: Quartiles, maximum and minimum of annual rainfall by station.

which are very close to zero and indicates that most stations have positively skewed distributions with only Sallochy (station VI) having a negative skew. On average in the Loch Lomond area, 70% of the years were normal, 15% rainy, 15% dry, with no extremely dry or extremely rainy years. This suggests proximity to the normal curve (see Table 4.2).

The probability of occurrence of rainy and dry years is on average approximately 15% for all the records but, over the last 30 years, the probability of rainy years is greater (16%) than dry years (14%). During the studied periods no extremely rainy and extremely dry years, occurred in excess of $3SD$ about the mean respectively. This suggests a extremely low probability of occurrence of extremes.

Apparently, there is no variation in terms of frequency and consequently probability across the basin. However it is important to note the differences between stations in terms of rainfall amounts. Thus, for Lairig the precipitation for a normal year lies between 2751 and 3651mm, for Balfron a normal year lies between 1118 and 1449mm of precipitation and the probability of having a normal year is 77% and 69% respectively.

Last 30 years

Over the last 30 years, there has been a relative increase in the number of normal and rainy years, whilst dry years have been decreasing in number (see Table 4.2). This is much more evident in Figures 4.2 and 4.3, where the largest amount of rainy years occurred in the last 12 years and particularly since 1984/85. This suggests that there is an increasing trend in the rainfall amounts in the Loch Lomond basin and this is confirmed by data from the control stations. However, for Allt Nan Caorrum (station I), Lairig (station II) and Balfron (station X), this period of rainy years is not so strongly marked. It should be noted that this very wet period followed a very dry period, between 1967/68 and 1978/79, for the whole area of the basin. The other exceptionally rainy period was between 1942/43 and 1949/50 and it also followed a relatively dry period, from 1933/34. A long, markedly dry period (22 years) was recorded in Helensburgh (station XII) only, between 1887/88 and 1908/09. It is clear that, in the Loch Lomond basin, temporal fluctuations that similarly affect the whole basin are the norm.

In terms of rainfall variability, there are two aspects under consideration; the variability can be measured in several different ways and time-scales. In Figure 4.2 a higher interannual variability can be discerned in the transitional periods, between rainy and

Station		class limits (mm)		1902/03 1931/32 N	%	1932/33 1961/62 N	%	1962/63 1991/92 N	%	Total of the series N	%
I	R	3340	4171					3	10.0%	7	15.9%
	N	2508	3340					21	70.0%	30	68.2%
	D	1677	2508					6	20.0%	7	15.9%
II	R	3652	4552					4	13.3%	5	11.4%
	N	2752	3652					23	76.7%	34	77.3%
	D	1852	2752					3	10.0%	5	11.4%
III	R	3020	3737					5	16.7%	8	17.4%
	N	2302	3020					20	66.7%	30	65.2%
	D	1585	2302					5	16.7%	8	17.4%
IV	R	2562	3174			4	13.3%	6	20.0%	12	13.8%
	N	1950	2562			19	63.3%	22	73.3%	64	73.6%
	D	1338	1950			7	23.3%	2	6.7%	11	12.6%
V	R	2672	3351					5	16.7%	6	19.4%
	N	1993	2672					19	63.3%	19	61.3%
	D	1313	1993					6	20.0%	6	19.4%
VIII	R	2356	2865			10	33.3%			11	16.4%
	N	1848	2356			15	50.0%			45	67.2%
	D	1339	1848			5	16.7%			11	16.4%
IX	R	2067	2572					6	20.0%	9	15.3%
	N	1562	2067					20	66.7%	41	69.5%
	D	1057	1562					4	13.3%	9	15.3%
X	R	1450	1780					3	10.0%	7	11.9%
	N	1119	1450					22	73.3%	41	69.5%
	D	789	1119					5	16.7%	11	18.6%
XI	R	1601	1953			4	13.3%	4	13.3%	10	14.3%
	N	1249	1601			24	80.0%	19	63.3%	50	71.4%
	D	897	1249			2	6.7%	7	23.3%	10	14.3%
XII	R	1566	1993	4	13.3%	5	16.7%	7	23.3%	18	15.3%
	N	1139	1566	23	76.7%	22	73.3%	21	70.0%	83	70.3%
	D	712	1139	3	10.0%	3	10.0%	2	6.7%	17	14.4%
XIV	R	2440	3009			4	13.3%	5	16.7%	11	14.3%
	N	1872	2440			18	60.0%	23	76.7%	54	70.1%
	D	1304	1872			8	26.7%	2	6.7%	12	15.6%
Mean	R	2430	3014	4	13.3%	5	18.0%	5	16.0%	9	14.8%
	N	1845	2430	23	76.7%	20	65.3%	21	70.0%	45	69.9%
	D	1260	1845	3	10.0%	5	16.7%	4	14.0%	10	15.2%
XIII	R	1165	1456			3	10.0%	6	20.0%	11	15.3%
	N	874	1165			23	76.7%	18	60.0%	51	70.8%
	D	583	874			4	13.3%	6	20.0%	10	13.9%

Notes:

1 The frequencies are divided in classes: (R) rainy, (N) normal and (D) dry and respective percentage (%) for periods of 30 years: 1902/03-1931/32, 1932/33 to 1961/62 and 1962/63 to 1991/92 and for the total for all periods for the selected groups of stations.

2 Stations VI and VII are not included due to the low number of variates.

3 Control station XIII (Glasgow Airport) is not included in the calculation of the mean due to its distance from the basin.

Table 4.2: The frequency of annual rainfall.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1871/72												R		
1872/73												N		
1873/74												N		
1874/75												N		
1875/76												N		
1876/77												R		
1877/78												N		
1878/79												N		
1879/80												D		
1880/81												N		
1881/82												N		
1882/83												N		
1883/84												R		
1884/85												N		
1885/86												N		
1886/87												N		
1887/88												D		
1888/89												N		
1889/90												N		
1890/91												D		
1891/92												N		
1892/93												D		
1893/94												N		
1894/95												D		
1895/96												D		
1896/97												D		
1897/98												D		
1898/99												N		
1899/1900														
1900/01														
1901/02												D		
1902/03												N		
1903/04												N		
1904/05												D		
1905/06				N								D		
1906/07				N								N		
1907/08				N								N		
1908/09				D								D		
1909/10				N								N		
1910/11				N								N		
1911/12				R								R		
1912/13				R								R		
1913/14				N								N		
1914/15				N								N		
1915/16				D								N		D
1916/17				N								N		D
1917/18				N								N		N
1918/19				N				D				N		N
1919/20				N				N				N		R
1920/21				N				N				N	N	N
1921/22				N				N				N	N	N
1922/23				N				N			N	N	N	N
1923/24				N				N			N	N	N	N
1924/25				N				N			N	N	N	N
1925/26				N				D			D	N	N	N
1926/27				N				N			R	R	R	N
1927/28				N				N			R	R	N	R
1928/29				N				N			N	N	N	N
1929/30				N				N			N	N	R	N
1930/31				N				N			N	N	N	N
1931/32				N				N			N	N	N	N

Figure 4.2: Annual rainfall variability 1871/72–1931/32.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1932/33				N				R			N	N	N	N
1933/34				D				D	D	D	N	D	D	D
1934/35				N				N	N	N	N	N	N	N
1935/36				D				N	N	N	N	N	N	D
1936/37				N				N	N	N	R	N	N	N
1937/38				D				N	N	D	N	N	N	N
1938/39				N				R	N	N	N	R	N	R
1939/40				D				D	D	D	D	D	D	D
1940/41				D				D	N	D	N	N	N	D
1941/42				N				N	N	N	N	N	N	N
1942/43				N				R	N	N	N	N	N	R
1943/44				N				N	N	N	N	N	N	N
1944/45				N				R	N	R	N	R	R	N
1945/46				N				N	N	N	N	N	N	N
1946/47			N	N				N	N	N	N	N	N	N
1947/48			R	R				R	R	R	R	R	R	N
1948/49	R	N	N	N				R	R	N	N	N	N	N
1949/50	R	R	R	R				R	R	R	R	R	R	R
1950/51	N	D	D	D				D	D	N	N	N	N	D
1951/52	N	N	N	N				N	N	N	N	N	N	D
1952/53	N	N	D	N				N	D	D	N	N	D	D
1953/54	N	N	N	R				R	N	R	R	R	N	N
1954/55	N	N	N	N				N	N	N	N	N	N	N
1955/56	N	N	N	N				N	D	N	N	N	N	N
1956/57	N	N	N	N				N	N	N	N	N	N	N
1957/58	N	N	N	N				N	N	N	N	N	N	N
1958/59	D	D	D	D				D	N	D	D	D	D	D
1959/60	N	N	N	N				N	N	N	N	N	N	N
1960/61	R	N	R	R				R	N	N	N	N	N	R
1961/62	R	N	N	N	R	R		R	N	N	N	N	N	N
1962/63	N	D	D	D	N	D		D	D	D	D	D	D	D
1963/64	N	N	N	N	N	N		N	N	N	N	N	N	N
1964/65	N	N	N	N	N	N		N	N	N	N	N	N	N
1965/66	N	N	N	N	N	N		N	N	N	N	N	N	N
1966/67	R	R	N	N	R	R		R	N	N	N	N	N	N
1967/68	D	N	D	N	N	N		N	N	N	N	N	N	N
1968/69	D	D	D	D	D	D		D	D	D	D	D	D	D
1969/70	N	N	N	N	N	N		D	N	N	N	N	N	N
1970/71	D	D	D	N	D	N	D	D	N	N	N	N	N	N
1971/72	N	N	N	N	N	N	D	N	D	N	D	N	D	N
1972/73	D	N	N	N	D	N	D	N	D	D	D	N	D	N
1973/74	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1974/75	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1975/76	D	N	D	N	D	N	D	N	N	N	D	N	D	N
1976/77	N	N	N	N	N	R	N	N	N	N	N	N	N	N
1977/78	D	N	N	N	N	N	N	N	N	N	N	N	N	N
1978/79	N	N	N	N	D	N	N	N	N	D	D	N	N	N
1979/80	N	N	N	N	N		R	N	R	N	N	N	N	N
1980/81	N	N	N	N	N		N	N	R	N	N	N	R	N
1981/82	N	N	N	N	N		N	N	N	N	N	N	N	N
1982/83	N	N	N	N	N		N	N	N	N	N	R	N	N
1983/84	N	N	N	N	D		N	N	N	D	D	N	D	N
1984/85	N	N	R	R	N		R	N	R	R	R	R	R	R
1985/86	N	N	N	N	N		N		N	N	N	N	N	N
1986/87	N	N	N	R	N		R		R	N	R	R	R	N
1987/88	N	N	R	R	R		R		N	N	N	R	R	R
1988/89	N	R	R	R	R		N		N	N	N	R	N	R
1989/90	R	R	R	R	R		R		R	R	R	R	R	R
1990/91	N	N	N	N	N		N		N	N	N	N	N	N
1991/92	R	R	R	R	R				R	R	R	R	R	R

	ER	Extremely rainy (> μ+3SD)
R	R	Rainy (μ+SD - μ+3SD)
	N	Normal (μ-SD - μ+SD)
D	D	Dry (μ-3SD - μ-SD)
	ED	Extremely dry (< μ-3SD)

Figure 4.3: Annual rainfall variability 1932/33–1991/92.

dry periods, when rainy years are interspersed with dry years. Nevertheless, for all the periods, the relative variability, shown by the coefficient of variation (see Table 4.1), is not very high (between 9% and 16%), and the Northern stations have similar coefficients, while Southern stations shown differences between them.

While the coefficients of variation shows a slight variation in variability for the area, without a defined pattern, if the standard deviations are taken in consideration (see Table 4.1) and also the inter quartile ranges (see Table 4.1 and Figure 4.1), different patterns of variability can be identified, because of the differences in raw values. Thus, although the inter quartile range is a "crude index of dispersion" [Hammond and McCullagh, 1978] the rainy North-western stations show a higher variability, in absolute terms. Similar patterns are conveyed by the standard deviation.

Based on the information given in the tables and figures presented in this subsection, representative stations, from different subareas of the basin area, were chosen in order to analyse the interannual variability relative to the mean. The results are presented in Figures 4.4 and 4.5, where the annual rainfall is presented as a percentage of the mean. Three aspects are evident from Figure 4.4 and 4.5, namely: the great variation from year to year, the dry periods and the wet periods. It is also possible to discern an increase in rainfall from the last very dry year (1968/69), because in spite of the interannual variability, the percentage of the mean rises continuously until the present and this holds for all parts of the basin. The greater variability occurred from 1909/10 to 1968/69, when dry years followed rainy years and vice-versa. Two periods, one wet and one dry, however can be discerned also with a great interannual variability. The wet period from 1941/42 to 1949/50 and the dry period from 1931/32 to 1941/42. This dry period is clearly shown for station IV, the longest series for the Northern. For Station XII the graph shows also the driest period measured at the transition of the century. Before 1884/85 the variability was very accentuated.

4.1.2 Seasonal variability

Table 4.3 summarises the statistical properties of Winter and Summer half-yearly rainfall series, for the selected stations. The variables listed in the first column, they characterise in general the seasonal rainfall for the Loch Lomond basin. A general relative stability, in average terms, is noticeable for the different time-scales (i.e. annual, Winter half-year and

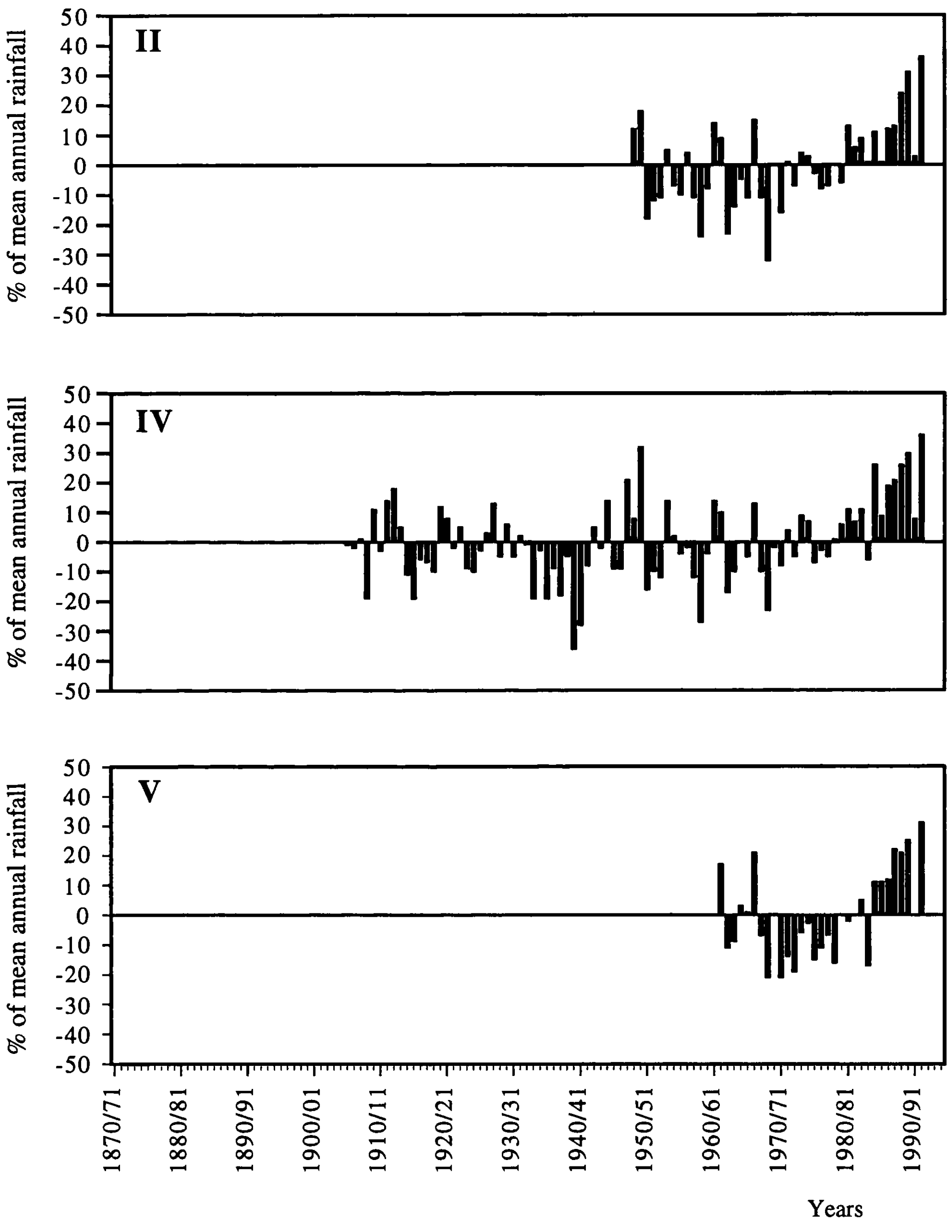

Figure 4.4: Interannual variability of annual rainfall (% of the mean) for representative stations II, IV and V.

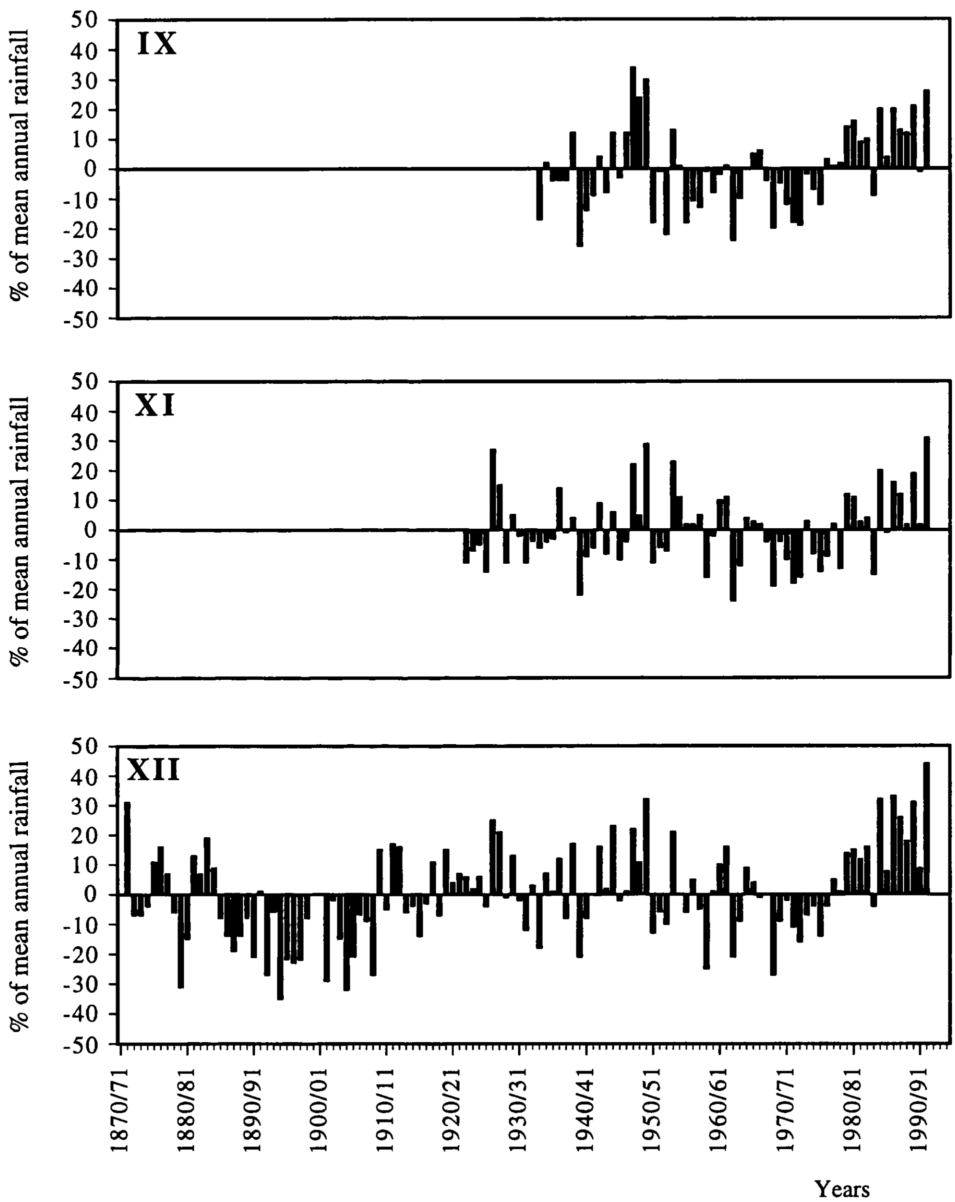

Figure 4.5: Interannual variability of annual rainfall (% of the mean) for representative stations IX, XI and XII.

Winter half-year (Oct-Mar)

stations	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
μ	1766	1958	1638	1362	1445	1060	1002	1186	1046	745	811	784	583	1322
SD	312	417	313	267	281	180	140	191	206	132	140	168	116	251
CV	18	21	19	20	19	17	14	16	20	18	17	21	20	19
skew	0.1	0.2	0.3	0.3	0.6	-0.4	0.0	0.2	0.2	0.1	0.2	0.0	0.0	0.2
min	1086	1127	1070	866	1024	771	699	855	664	501	520	411	346	827
Q1	1564	1695	1445	1190	1237	916	896	1033	883	648	701	687	508	1172
Me	1703	1955	1614	1374	1420	1097	987	1184	1053	752	807	789	581	1332
Q2	1996	2219	1858	1527	1605	1176	1101	1319	1173	822	912	897	654	1488
max	2328	2894	2442	2135	2096	1292	1262	1666	1538	1049	1140	1182	816	2064
N	44	44	46	87	31	18	21	67	59	59	70	119	72	77

Summer half-year (Apr-Sep)

stations	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
μ	1035	1252	1027	892	898	748	615	908	768	537	613	566	437	830
SD	207	218	215	171	200	117	137	171	144	107	122	108	84	159
CV	20	17	21	19	22	16	22	19	19	20	20	19	19	19
skew	0.7	0.2	0.5	0.6	0.5	0.4	1.7	0.6	0.7	0.5	0.7	0.7	0.6	0.6
min	600	841	651	549	530	529	382	567	492	266	313	362	222	526
Q1	909	1110	893	787	765	671	556	808	690	463	526	490	386	710
Me	1022	1237	962	868	833	707	584	891	746	526	595	553	429	807
Q2	1141	1397	1146	1002	1030	819	629	1003	845	599	679	615	484	902
max	1718	1822	1537	1470	1355	952	1060	1363	1192	853	974	905	728	1349
N	45	45	47	88	32	19	22	70	60	60	71	121	72	78

Table 4.3: Summary statistics of seasonal (Winter, Oct–Mar and Summer, Apr–Sep) rainfall amounts for the selected stations.

Summer half-year). Thus, the measures of central tendency indicate the Northwest as the wettest part of the basin for both seasons, illustrated by station II, where the Winter mean and median is 1958mm and 1955mm and the Summer 1252mm and 1237mm respectively. In contrast the driest part of the basin, the Southeast, is illustrated by station X with a Winter mean and median of 745mm and 752mm of median and a Summer mean and median of 537mm and 526mm (see Figures 4.6). The similarity between mean and median, not only for these two stations but for all stations, shows a frequency distribution close to normal. In Summer, the median is invariably lower than the mean revealing a positive skewness. In Winter, some stations have lower median than the mean and vice-versa and the skewness coefficient reveals positive distributions more close to the normal (stations VII, XII and XIII). Station VI has an unusual negative skewness similar to the annual series. In general the Winter series shows less skewness than the Summer series or the annual series.

In spite of positively skewed distributions, on average, rainy and dry winters have the

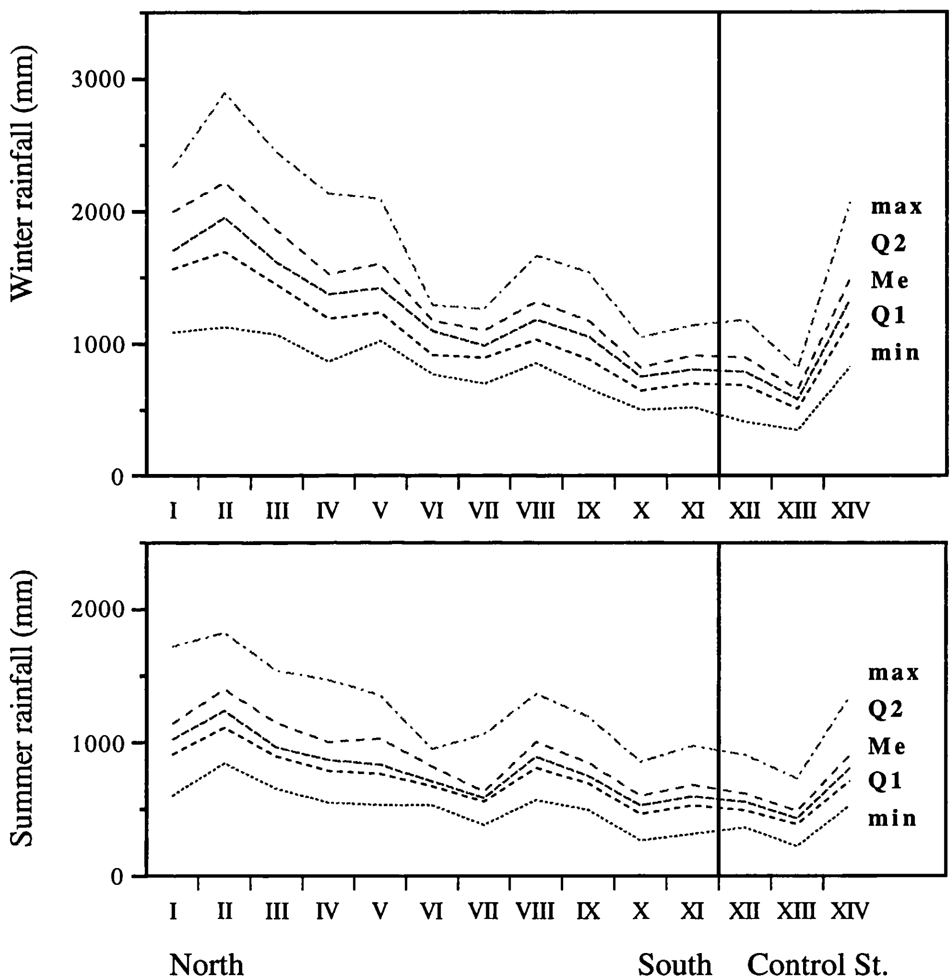

Figure 4.6: Quartiles and extremes of (a) Winter half-year and (b) Summer half-year rainfall by selected station.

same 16% probability of occurrence (see Table 4.4). On the other hand, rainy summers are more frequent than dry summers in the Loch Lomond basin, which gives 15% probability for rainy summers and 12% probability for dry summers (see Table 4.5). However, the greatest percentage is for normal years (between μ-SD and μ+SD), 68% likehood for Winter and 71% likehood for Summer. There is also a 2% probability of occurrence of extremely rainy years. In general terms for all stations, the relative frequencies are slightly higher for normal summers than normal winters and the percentage of dry and rainy years are more alike for Winter.

Spatially within the basin, there are no defined patterns of frequency and probability variations. Nevertheless, through the analysis of frequency of normal, rainy and dry summers and winters by equal number of years (presented in Tables 4.4 and 4.5), it is evident a higher percentage (between 30% and 17%) of rainy winters in the last 30 years, for all the stations. The most significant occurrences over the last 30 years are at station IV with 30% of rainy winters against 10% of dry winters and station XII with 27% of rainy winters against 13% of dry winters. Furthermore, for the Loch Lomond basin, this period is the wettest in terms of rainy winters, even for the longest series at Helensburgh.

In the last 30 years for most of the stations, rainy summers predominate over dry summers, but the difference is not great. The same cannot be said for the period of 1932/33–1961/62 when the percentage of rainy summers was similar to that of the last 30 winters. However in terms of frequency and probability, there are no defined patterns at the spatial scale of the basin.

Figures 4.7, 4.8, 4.9 and 4.10 allow an examination of Winter and Summer rainfall variability through time for all the stations. Thus, taking into account the recent increasing trend in the annual rainfall amounts, it can be seen that that the higher frequency of rainy winters began in 1973/74, whilst a higher frequency of rainy summers began in 1984/85. This accentuates the annual increase, for the whole basin, after 1984/85. The transition from dry summers to rainy summers was extraordinarily abrupt. While 1983/84 was a dry Summer for all stations, 1984/85 was a rainy Summer for several stations and extremely rainy for stations I, IV, VII, XII, XIII and XIV. This is an anomaly, both for short and long term variability.

Before these rainy periods, dry winters began in 1950/51 and dry summers in 1967/68. That contributes to an annual dryness from 1968/69 to 1972/73 and a marked seasonal

Station		class limits (mm)		1902/03 1931/32 N	%	1932/33 1961/62 N	%	1962/63 1991/92 N	%	Total of the series N	%
I	R	2078	2702					6	20.0%	8	19.0%
	N	1454	2078					20	66.7%	27	64.3%
	D	829	1454					4	13.3%	7	16.7%
II	R	2375	3209					6	20.0%	6	13.6%
	N	1541	2375					21	70.0%	32	72.7%
	D	707	1541					3	10.0%	6	13.6%
III	R	1952	2579					5	16.7%	6	13.0%
	N	1325	1952					22	73.3%	32	69.6%
	D	698	1325					3	10.0%	8	17.4%
IV	R	1629	2162			1	3.3%	9	30.0%	13	14.9%
	N	1096	1629			18	60.0%	18	60.0%	58	66.7%
	D	563	1096			11	36.7%	3	10.0%	16	18.4%
V	R	1726	2288					7	23.3%	7	22.6%
	N	1164	1726					17	56.7%	18	58.1%
	D	602	1164					6	20.0%	6	19.4%
VIII	R	1377	1760			5	16.7%			11	16.4%
	N	994	1377			19	63.3%			44	65.7%
	D	612	994			6	20.0%			12	17.9%
IX	R	1253	1665					6	20.0%	10	16.9%
	N	840	1253					21	70.0%	40	67.8%
	D	428	840					3	10.0%	9	15.3%
X	R	877	1142					5	16.7%	8	13.6%
	N	613	877					21	70.0%	41	69.5%
	D	348	613					4	13.3%	10	16.9%
XI	R	951	1232			5	16.7%	7	23.3%	13	18.6%
	N	670	951			21	70.0%	19	63.3%	47	67.1%
	D	390	670			4	13.3%	4	13.3%	10	14.3%
XII	R	953	1289	5	16.7%	4	13.3%	8	26.7%	19	16.0%
	N	616	953	23	76.7%	22	73.3%	18	60.0%	80	67.2%
	D	279	616	2	6.7%	4	13.3%	4	13.3%	20	16.8%
XIV	R	1573	2076			2	6.7%	6	20.0%	11	14.3%
	N	1071	1573			21	70.0%	20	66.7%	54	70.1%
	D	569	1071			7	23.3%	4	13.3%	12	15.6%
Mean	R	1522	2009	5	16.7%	3	11.3%	7	21.7%	10	16.0%
	N	1035	1522	23	76.7%	20	67.3%	20	65.7%	43	67.5%
	D	548	1035	2	6.7%	6	21.3%	4	12.7%	11	16.5%
XIII	R	699	932			4	13.3%	8	26.7%	14	19.4%
	N	466	699			21	70.0%	16	53.3%	45	62.5%
	D	233	466			5	16.7%	6	20.0%	13	18.1%

Notes:

1. The frequencies are divided in classes: (R) rainy, (N) normal and (D) dry and respective percentage (%) for periods of 30 years: 1902/03-1931/32, 1932/33 to 1961/62 and 1962/63 to 1991/92 and for the total for all periods for the selected groups of stations.
2. Stations VI and VII are not included due to its short number of variates.
3. Control station XIII (Glasgow Airport) is not included in the calculation of the mean due to its distance from the basin.

Table 4.4: Frequency of Winter half-year rainfall.

Station		class limits (mm)		1902/03 1931/32 N	%	1932/33 1961/62 N	%	1962/63 1991/92 N	%	Total of the series N	%
I	ER	1657						1	3.3%	1	2.2%
	R	1242	1657					3	10.0%	5	11.1%
	N	828	1242					23	76.7%	33	73.3%
	D	414	828					3	10.0%	6	13.3%
II	R	1470	1907					5	16.7%	8	17.8%
	N	1034	1470					21	70.0%	32	71.1%
	D	597	1034					4	13.3%	5	11.1%
III	R	1242	1672					4	13.3%	8	17.0%
	N	812	1242					21	70.0%	33	70.2%
	D	382	812					5	16.7%	6	12.8%
IV	ER	1406						1	3.3%	1	1.1%
	R	1064	1406			7	23.3%	4	13.3%	12	13.6%
	N	721	1064			16	53.3%	21	70.0%	60	68.2%
	D	378	721			7	23.3%	4	13.3%	15	17.0%
V	R	1098	1498					4	13.3%	6	18.8%
	N	698	1098					23	76.7%	23	71.9%
	D	298	698					3	10.0%	3	9.4%
VIII	R	1079	1421			8	26.7%			10	14.3%
	N	738	1079			20	66.7%			52	74.3%
	D	396	738			2	6.7%			8	11.4%
IX	R	912	1200			4	13.3%	5	16.7%	9	15.0%
	N	624	912			22	73.3%	20	66.7%	42	70.0%
	D	336	624			4	13.3%	5	16.7%	9	15.0%
X	R	645	859			7	23.3%	4	13.3%	11	18.3%
	N	430	645			19	63.3%	25	83.3%	44	73.3%
	D	215	430			4	13.3%	1	3.3%	5	8.3%
XI	R	735	979			7	23.3%	3	10.0%	11	15.5%
	N	491	735			20	66.7%	23	76.7%	53	74.6%
	D	247	491			3	10.0%	4	13.3%	7	9.9%
XII	ER	892						1	3.3%	1	0.8%
	R	675	892	2	6.7%	8	26.7%	4	13.3%	18	14.9%
	N	458	675	23	76.7%	20	66.7%	22	73.3%	85	70.2%
	D	241	458	6	20.0%	2	6.7%	3	10.0%	17	14.0%
XIV	ER	1308						1	3.3%	1	1.3%
	R	990	1308			6	20.0%	3	10.0%	10	12.8%
	N	671	990			20	66.7%	23	76.7%	57	73.1%
	D	353	671			4	13.3%	3	10.0%	10	12.8%
Mean	ER	1316						1	3.3%	1	1.5%
	R	1014	1345	2	6.7%	7	22.4%	4	13.0%	10	14.9%
	N	682	1014	23	76.7%	20	65.2%	22	74.0%	47	71.0%
	D	351	682	6	20.0%	4	12.4%	4	11.7%	8	12.6%
XII	ER	690						1	3.3%	1	1.4%
	R	521	690			5	16.7%	3	10.0%	9	12.5%
	N	353	521			19	63.3%	22	73.3%	52	72.2%
	D	184	353			6	20.0%	4	13.3%	10	13.9%

Notes:

1. The frequencies are divided in classes: (ER) extreme rainy, (R) rainy, (N) normal and (D) dry and respective percentage (%) for periods of 30 years: 1902/03-1931/32, 1932/33 to 1961/62 and 1962/63 to 1991/92 and for the total for all periods for the selected groups of stations.
2. Stations VI and VII are not included due to its short number of variates.
3. Control station XIII (Glasgow Airport) is not included in the calculation of the mean due to its distance from the basin.

Table 4.5: Frequency of Summer half-year rainfall.

variability up till 1984/85. There are no defined periods of rainy winters prior to 1949/50, but there is a strong variability from 1909/10. On the other hand, a period of rainy summers occurred from 1941/42 to 1964/65 with only scattered dry summers. Very marked rainy summers occurred in the whole basin for the period 1942/43 to 1949/50 and together with scattered rainy winters, this is reflected in a period of high annual rainfall. There was a tendency to dry years between 1919/20 and 1940/41 preceded by a long period of dry summers from 1879/80, the data from before 1905 relatively to station XII (Helensburgh) only. A shorter period of dry winters coincided with dry summers from 1887/88 to 1908/09. The first Helensburgh records show a relatively high variability. The rainfall variability over this time scale reflects the same patterns for the basin as a whole.

The temporal rainfall variability in absolute values can be measured by the standard deviation and inter quartile range which reflects also the spatial patterns of variability. For Winter and Summer, spatial patterns similar to annual rainfall are verified, i.e., great variability for the Northwest part of the basin and least variability for the Southeast (see Table 4.3 and Figures 4.6). Only the Summer inter quartile range for station VII was anomalous, and this may be because of the short period of record (22 years). As was expected, the variability in absolute terms, is lower for Summer and consequently the Winter has absolute variability close to the annual values. However the relative variability, measured by the coefficient of variation is very similar, when comparing Winter (between 14% and 21%) and Summer (between 16% and 22%), which are higher than the annual values (between 9 and 15%). For all these time scales the coefficients of variation shows a slight variation in space, but without a defined pattern.

Likewise, on an annual time scale, the interannual variability relative to the mean for Winter and Summer is described only for representative stations. The results are presented in Figures 4.11 and 4.12 for Winter and in Figures 4.13 and 4.14 for the Summer.

In general terms, the Winter and Summer graphs show greater variability than for annual rainfall and reflects the pattern described above. The most evident is the non-existence of dry winters since the beginning of the 70s, when most of the normal years are above the mean. The greater variability between 1983/84 and 1984/85 is also clear for the Summer graphs, which are from 37% below the mean to 65% above the mean for station IV, and even greater for station VII (not graphically represented) with 38% and 73% respectively. For winters between 1910/11 and 1968/69 there was a great variability, with

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1871/72												N		
1872/73												N		
1873/74												N		
1874/75												N		
1875/76												R		
1876/77												N		
1877/78												N		
1878/79												D		
1879/80												D		
1880/81												D		
1881/82												N		
1882/83												N		
1883/84												R		
1884/85												N		
1885/86												N		
1886/87												N		
1887/88												D		
1888/89												N		
1889/90												N		
1890/91												D		
1891/92												N		
1892/93												D		
1893/94												N		
1894/95												D		
1895/96												N		
1896/97												D		
1897/98												D		
1898/99												N		
1899/1900														
1900/01														
1901/02												D		
1902/03												N		
1903/04												N		
1904/05												D		
1905/06				N								N		
1906/07				N								N		
1907/08				N								N		
1908/09				D								D		
1909/10				N								N		
1910/11				N								N		
1911/12				R								R		
1912/13				R								R		
1913/14				N								N		
1914/15				N								N		
1915/16				N								N		N
1916/17				N								N		N
1917/18				N								R		N
1918/19				N				N				N		N
1919/20				N				N				N		R
1920/21				R				N				N	N	N
1921/22				N				N				N	N	N
1922/23				N				N			D	N	D	N
1923/24				D				D			D	N	D	D
1924/25				N				D			N	N	N	N
1925/26				N				N			N	N	N	N
1926/27				N				N			N	N	N	N
1927/28				N				N			R	R	R	R
1928/29				N				N			N	N	N	N
1929/30				N				N			N	R	R	R
1930/31				N				N			N	N	N	N
1931/32				N				N			N	N	N	N

Figure 4.7: Winter rainfall variability 1871/72–1931/32.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1932/33				N				R			N	N	R	R
1933/34				D				D	D	D	D	D	D	D
1934/35				N				N	N	N	N	N	N	N
1935/36				N				N	N	N	N	N	N	N
1936/37				N				N	N	N	R	R	N	N
1937/38				D				N	N	D	N	N	N	N
1938/39				N				R	R	R	R	R	R	R
1939/40				D				N	D	N	D	N	N	D
1940/41				D				N	N	N	N	N	N	N
1941/42				D				D	D	N	N	N	N	N
1942/43				N				N	N	N	N	N	N	N
1943/44				N				N	N	N	N	N	N	N
1944/45				N				R	N	R	N	N	R	N
1945/46				D				N	N	N	D	N	N	N
1946/47			D	D				D	N	N	N	N	N	D
1947/48			N	N				N	N	N	N	N	N	N
1948/49	R	N	R	N				R	R	N	R	R	N	N
1949/50	R	N	N	R				R	R	R	R	R	R	N
1950/51	D	D	D	D				D	N	N	N	N	N	D
1951/52	N	N	N	N				N	N	N	N	N	N	N
1952/53	D	D	D	D				D	D	D	N	D	D	D
1953/54	N	N	N	N				N	N	N	N	N	N	N
1954/55	N	N	N	N				N	R	N	R	N	N	N
1955/56	N	N	D	N				N	D	D	N	N	D	D
1956/57	N	N	N	N				N	N	N	N	N	N	N
1957/58	N	N	N	D				N	D	D	N	D	D	N
1958/59	D	D	D	D				D	N	D	D	D	D	D
1959/60	N	N	N	N				N	N	N	N	N	N	N
1960/61	N	N	N	N				N	N	N	N	N	N	N
1961/62	N	N	N	N	N	N		N	N	N	N	N	N	N
1962/63	D	D	D	D	D	D		D	D	D	D	D	D	D
1963/64	D	D	D	D	D	D		D	D	D	D	D	D	D
1964/65	N	N	N	N	D	D		N	N	N	N	N	D	D
1965/66	N	N	N	N	N	N		N	N	N	N	N	N	N
1966/67	R	N	N	N	R	N		R	N	N	N	N	N	N
1967/68	N	N	N	N	N	N		N	N	N	N	N	N	N
1968/69	D	D	D	D	D	D		D	D	D	D	D	D	D
1969/70	D	N	N	N	N	N		N	N	N	N	N	N	N
1970/71	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1971/72	N	N	N	N	D	N	D	N	N	N	N	N	D	N
1972/73	N	N	N	N	D	N	D	N	N	D	D	D	D	N
1973/74	N	N	N	R	N	R	N	R	N	N	R	N	N	N
1974/75	N	N	N	R	N	R	N	R	N	N	N	N	N	N
1975/76	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1976/77	N	N	N	N	N	R	N	N	N	N	N	N	N	N
1977/78	N	N	N	N	N	N	N	R	N	N	N	N	R	N
1978/79	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1979/80	N	N	N	N	N		N	N	N	N	N	R	N	N
1980/81	N	N	N	R	N		N	R	R	N	R	R	R	N
1981/82	N	N	N	N	N		N	N	N	N	N	N	N	N
1982/83	R	R	R	R	R		R	N	R	R	R	R	R	R
1983/84	N	R	N	N	N		N	R	N	N	N	N	N	N
1984/85	N	N	N	N	N		N	D	N	N	N	N	N	N
1985/86	N	N	N	N	N		N		N	N	N	N	N	N
1986/87	R	R	R	R	R		R		R	R	R	R	R	R
1987/88	N	N	N	R	R		N		N	N	N	R	R	R
1988/89	R	R	R	R	R		R		R	R	R	R	R	R
1989/90	R	R	R	R	R		R		R	R	R	R	R	R
1990/91	N	N	N	N	N		N		N	N	N	N	N	N
1991/92	R	R	R	R	R				R	R	R	R	R	R

ER Extremely rainy (> μ+3SD)
R **R** Rainy (μ+SD - μ+3SD)
N Normal (μ-SD - μ+SD)
D **D** Dry (μ-3SD - μ-SD)
ED Extremely dry (< μ-3SD)

Figure 4.8: Winter rainfall variability 1832/33–1991/92.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1870/71												N		
1871/72												R		
1872/73												N		
1873/74												N		
1874/75												N		
1875/76												N		
1876/77												R		
1877/78												N		
1878/79												R		
1879/80												D		
1880/81												N		
1881/82												N		
1882/83												N		
1883/84												N		
1884/85												N		
1885/86												N		
1886/87												D		
1887/88												N		
1888/89												N		
1889/90												N		
1890/91												N		
1891/92												R		
1892/93												N		
1893/94												D		
1894/95												N		
1895/96												D		
1896/97												N		
1897/98												N		
1898/99												D		
1899/1900														
1900/01												D		
1901/02												D		
1902/03												N		
1903/04												D		
1904/05				N								D		
1905/06				N								D		
1906/07				N								N		
1907/08				N								N		
1908/09				N								N		
1909/10				N								N		
1910/11				N				N				N		
1911/12				N								N		
1912/13				D								N		
1913/14				N								N		
1914/15				D				D				D		D
1915/16				D								N		D
1916/17				N								N		N
1917/18				D				N				N		N
1918/19				N				D				D		D
1919/20				N				N				N		N
1920/21				N				N				N	N	N
1921/22				N				N			N	N	N	N
1922/23				R				N			N	R	N	R
1923/24				N				N			N	N	N	N
1924/25				N				N			N	N	N	N
1925/26				N				N			N	N	N	N
1926/27				N				N			R	R	R	N
1927/28				N				N			N	N	N	N
1928/29				N				N			N	N	N	N
1929/30				N				N			N	N	N	N
1930/31				N				N			N	N	N	N
1931/32				N				N			N	N	N	N

Figure 4.9: Summer rainfall variability 1871/72–1931/32.

Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1932/33				D				N	N	D	D	D	D	N
1933/34				N				N	N	N	R	N	N	N
1934/35				N				N	N	N	N	N	N	N
1935/36				D				N	N	N	D	N	N	N
1936/37				N				N	N	N	N	N	N	N
1937/38				N				R	N	N	N	N	N	N
1938/39				D				N	N	N	D	N	D	N
1939/40				D				D	D	D	N	D	D	D
1940/41				D				D	D	D	N	N	D	D
1941/42				N				R	N	N	N	N	N	R
1942/43				R				R	N	R	R	R	R	R
1943/44				N				N	N	N	N	N	N	N
1944/45				N				N	N	R	N	R	R	N
1945/46			N	N				N	N	N	N	N	N	N
1946/47			R	R				N	R	R	N	R	R	N
1947/48	N	R	R	R				R	R	R	R	R	R	R
1948/49	N	N	N	N				N	N	N	N	N	N	N
1949/50	R	R	R	R				R	R	R	R	R	R	R
1950/51	N	N	N	N				N	N	N	N	N	N	N
1951/52	N	N	D	N				N	D	N	N	N	N	D
1952/53	N	N	N	N				N	N	N	N	N	N	N
1953/54	N	N	N	R				R	R	R	R	R	N	N
1954/55	D	D	N	D				N	D	D	N	N	D	D
1955/56	N	N	N	N				N	N	N	N	N	N	N
1956/57	D	N	N	N				N	N	N	N	N	N	N
1957/58	N	N	N	N				N	N	N	R	N	N	N
1958/59	D	N	N	D				N	N	N	N	N	D	N
1959/60	N	N	N	N				N	N	N	N	N	N	N
1960/61	R	R	R	R	R	R		R	N	R	R	R	N	R
1961/62	N	N	N	R	R	R		R	N	N	N	R	N	R
1962/63	N	N	N	N	N	N		N	N	N	N	N	N	N
1963/64	N	R	R	R	N	R		R	R	N	N	R	N	N
1964/65	N	R	R	R	R	R		N	R	R	R	R	R	R
1965/66	N	N	N	N	N	N		N	N	N	N	N	N	N
1966/67	N	N	N	N	N	N		N	N	N	N	N	N	N
1967/68	D	D	D	N	N	N		N	N	N	N	N	N	N
1968/69	N	N	N	N	N	N		N	N	N	N	N	N	N
1969/70	R	R	N	N	N	N	N	D	N	N	N	N	N	N
1970/71	D	D	D	D	D	D	D	D	D	N	D	N	D	D
1971/72	N	N	N	N	N	N	N	N	N	N	D	N	N	N
1972/73	N	N	N	N	N	N	N	N	D	N	N	N	N	N
1973/74	N	N	N	N	N	N	N	N	N	N	N	D	D	N
1974/75	N	N	N	N	N	N	N	N	D	N	N	N	N	N
1975/76	N	N	D	N	N	N	N	N	D	N	N	D	D	N
1976/77	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1977/78	N	N	N	D	N	D	N	N	N	N	N	N	N	D
1978/79	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1979/80	N	N	N	N	N		R	N	N	N	N	N	N	N
1980/81	N	N	N	N	N		N	N	N	N	N	N	R	N
1981/82	N	N	N	N	N		N	N	N	N	N	N	N	N
1982/83	N	D	D	D	D		N	D	N	N	D	N	N	N
1983/84	D	D	D	D	D		D	D	D	D	D	D	D	D
1984/85	ER	R	R	ER	R		ER	R	R	R	R	ER	ER	ER
1985/86	N	N	N	N	N		N		N	N	N	N	N	N
1986/87	N	N	N	N	N		N		N	N	N	N	N	N
1987/88	R	N	N	R	R		R		R	R	N	R	N	R
1988/89	N	N	N	N	N		N		N	N	N	N	N	N
1989/90	N	N	N	N	N		N		N	N	N	N	N	N
1990/91	N	N	N	N	N		N		N	N	N	N	N	N
1991/92	R	R	R	R	R				R	R	R	R	R	R

ER **ER** Extremely rainy (> μ+3SD)
R **R** Rainy (μ+SD - μ+3SD)
N Normal (μ-SD - μ+SD)
D **D** Dry (μ-3SD - μ-SD)
ED Extremely dry (< μ-3SD)

Figure 4.10: Summer rainfall variability 1832/33–1991/92.

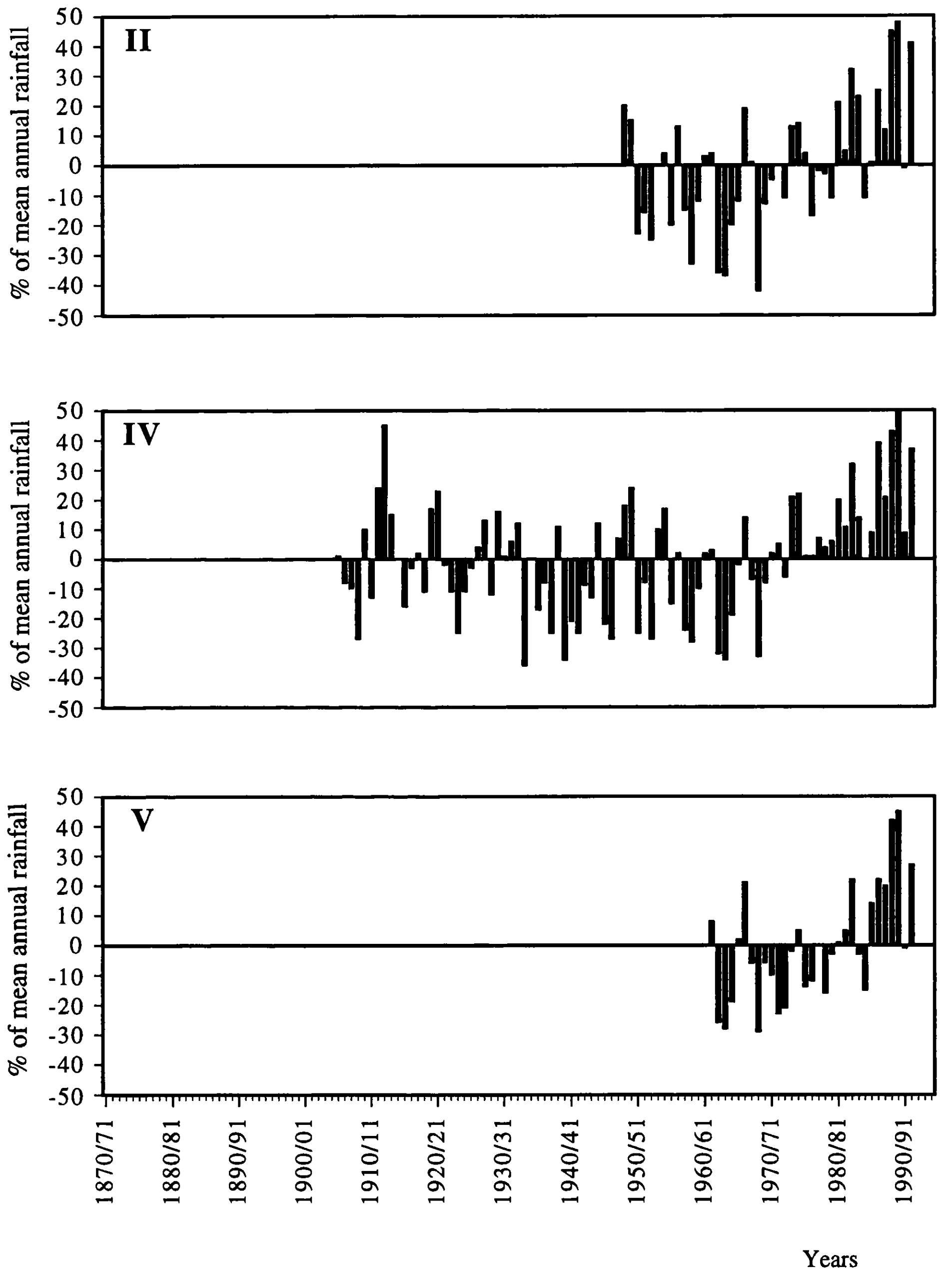

Figure 4.11: Interannual variability of Winter rainfall (% of the mean) for representative stations II, IV and V.

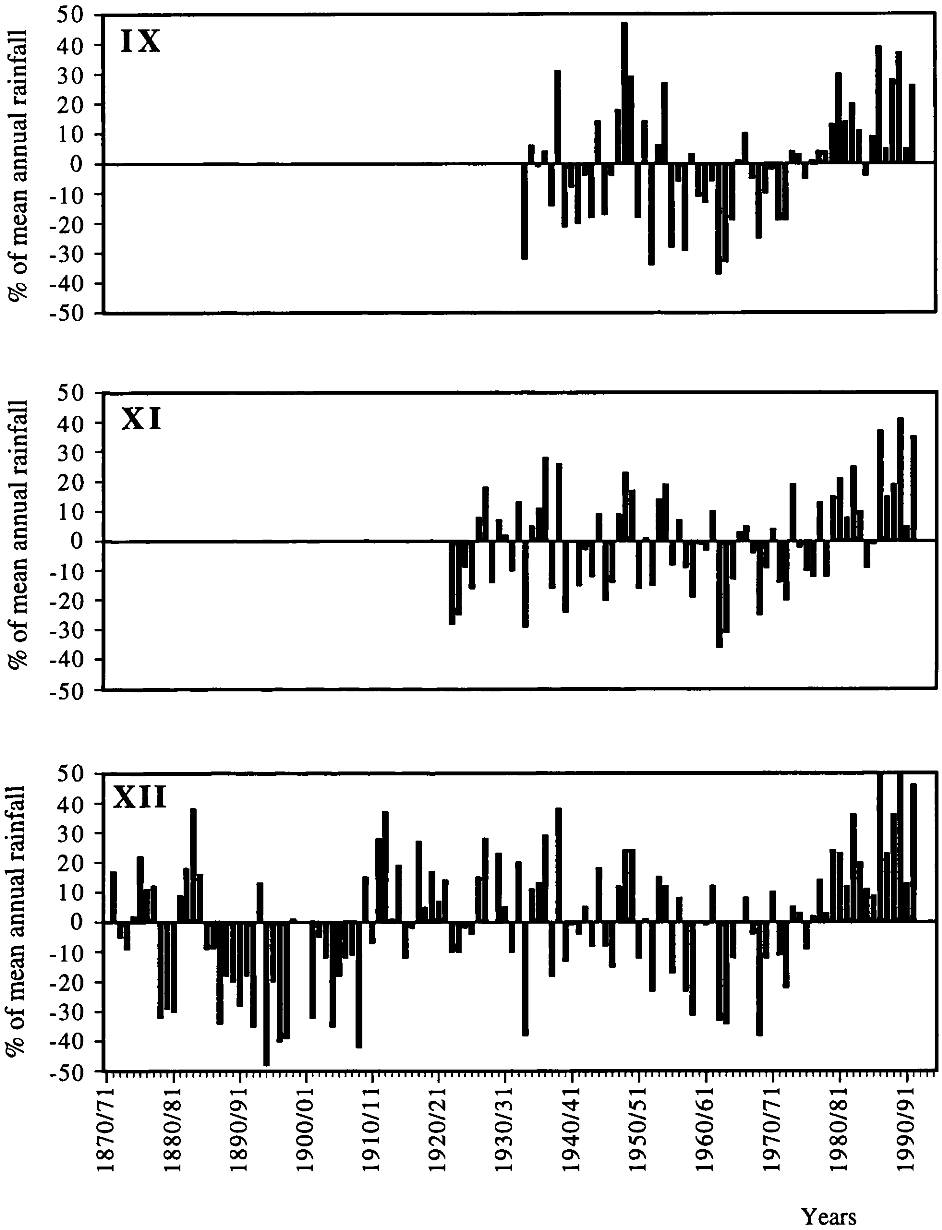

Figure 4.12: Interannual variability of Winter rainfall (% of the mean) for representative stations IX, XI and XII.

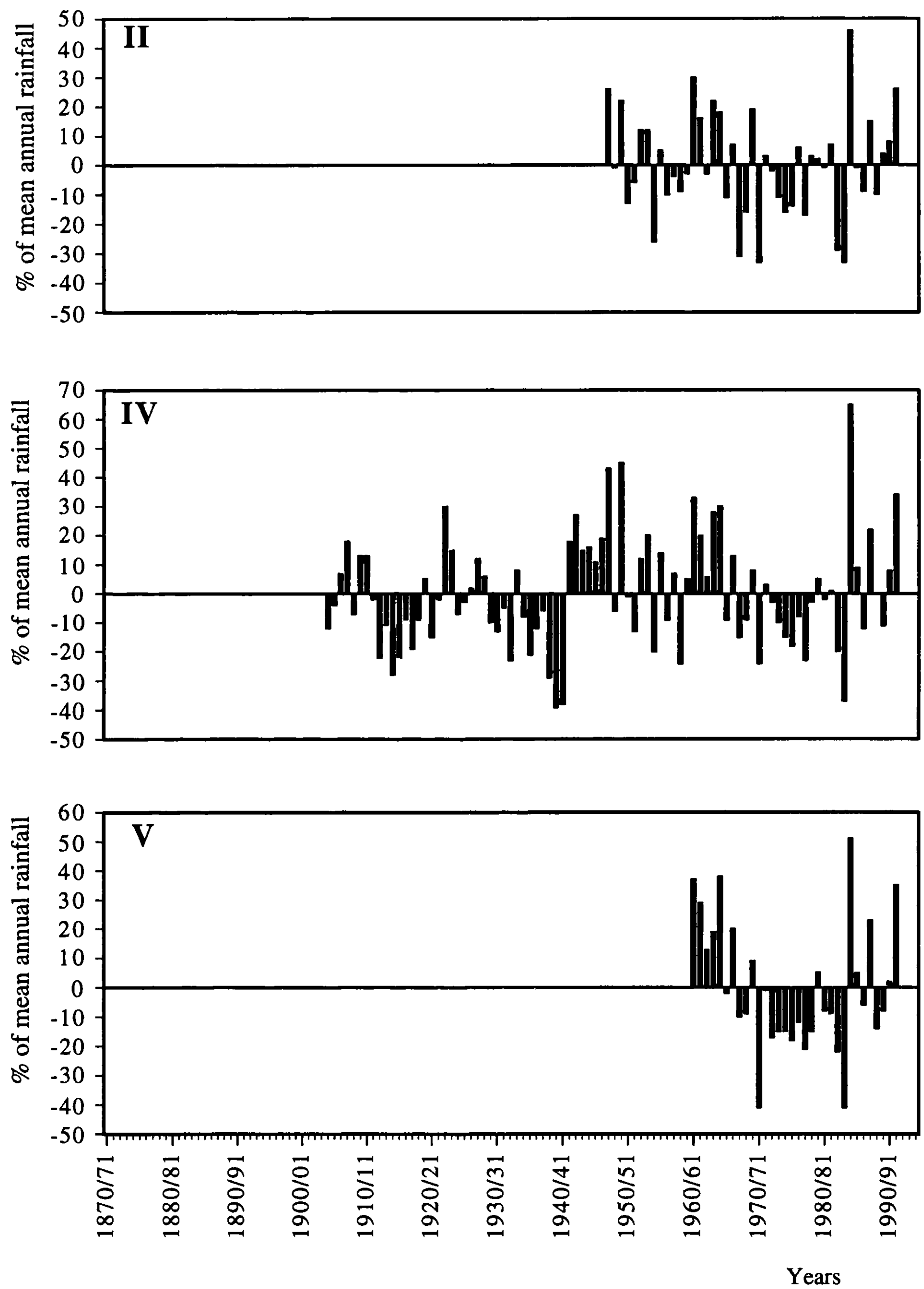

Figure 4.13: Interannual variability of Summer rainfall (% of the mean) for representative stations II, IV and V.

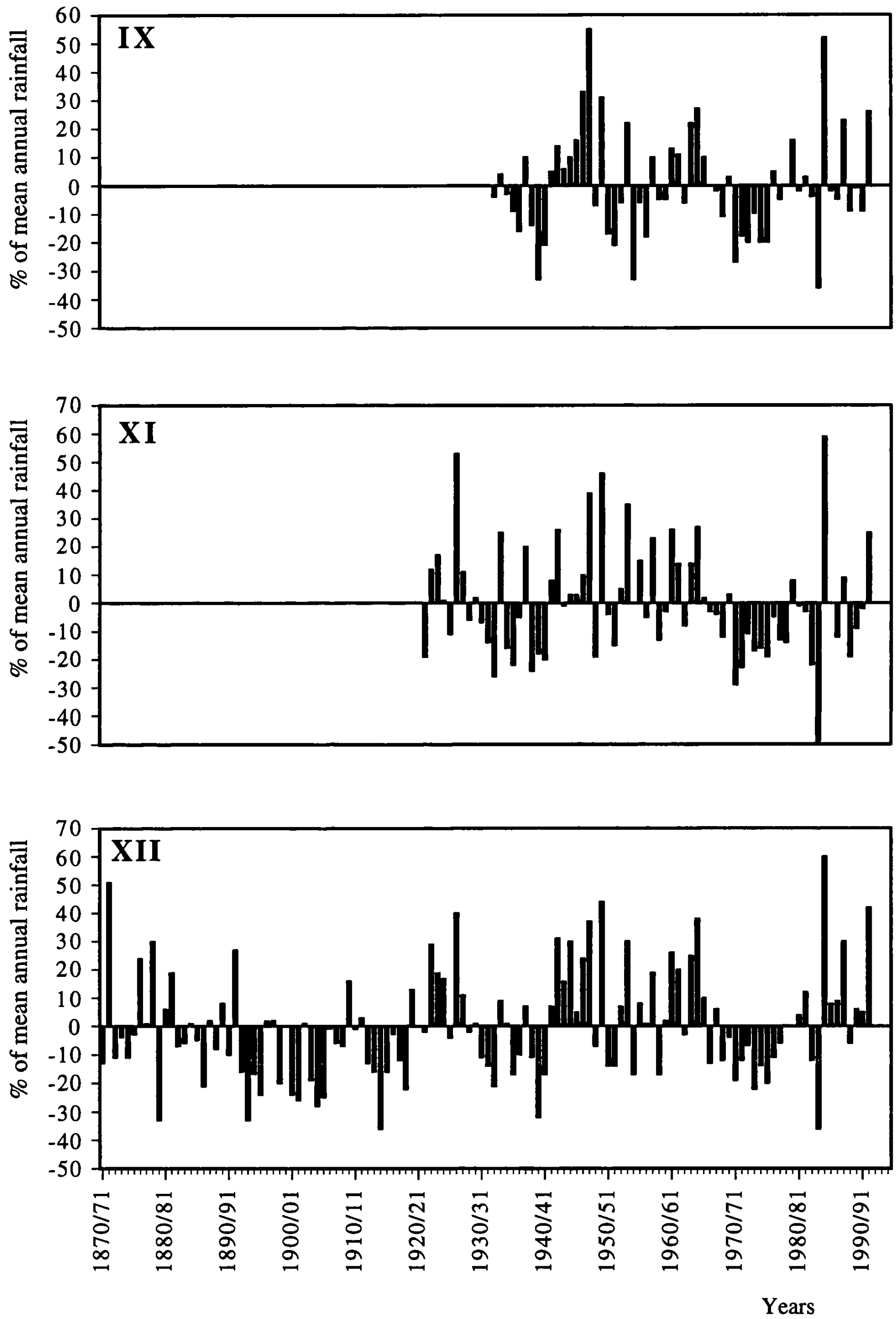

Figure 4.14: Interannual variability of Summer rainfall (% of the mean) for representative stations IX, XI and XII.

a tendency for dryness, while for Summer almost cyclic rainy and dry periods occurred, specially for stations IV and XII. The dry winters and summers at the end of the nineteenth century and the beginning of present century are also clear on the Helensburgh plots.

4.2 Trends and fluctuations

In this section the trends and fluctuations in rainfall are identified and analysed for eleven stations chosen to be widely spread over the Loch Lomond catchment area, together with the three control stations outwits the basin. This analysis was performed using annual and seasonal rainfall amounts.

4.2.1 Annual

The annual rainfall amounts expressed in millimetres, for the selected stations, are shown in Figures 4.15–4.17. The actual rainfall values are plotted with a light dotted line, the moving average with a continuous line and the fitted polynomial curve with a heavy dashed line.

The graphs show strong oscillations of **actual rainfall** from year to year, which makes it difficult to recognise general fluctuations and trends. However, it is possible to identify patterns in the interannual rainfall variability. First there is a larger interannual amplitude in the rainfall values for the stations located in the North of the basin (e.g. station I, II, III, IV). Second, lower variation in the interannual variability of rainfall is noted in the last two decades, and is particularly marked in Allt Nan Caorrum (station I), Lairig (station II) and Sloy Power Station (station III). From the actual values it is possible also to identify larger scale variations in the total amounts of annual of rainfall, such as the clear increase in the last 20 years.

Fluctuations and trends are much more clear when described by the smoothing lines plotted. A five-year moving averages and a 5th order polynomial curve fit have been included in the graphs to facilitate the identification of trends and fluctuations. There is a very clear increasing trend in rainfall amounts from the beginning of the 70s in the Loch Lomond basin, in both the **5-year moving average** and the polynomial curve fit. This trend is also evident in the data for the three control stations, located outside of the basin: Helensburgh (station XII), Renfrew-Glasgow Airport (station XIII) and Stronachlachar

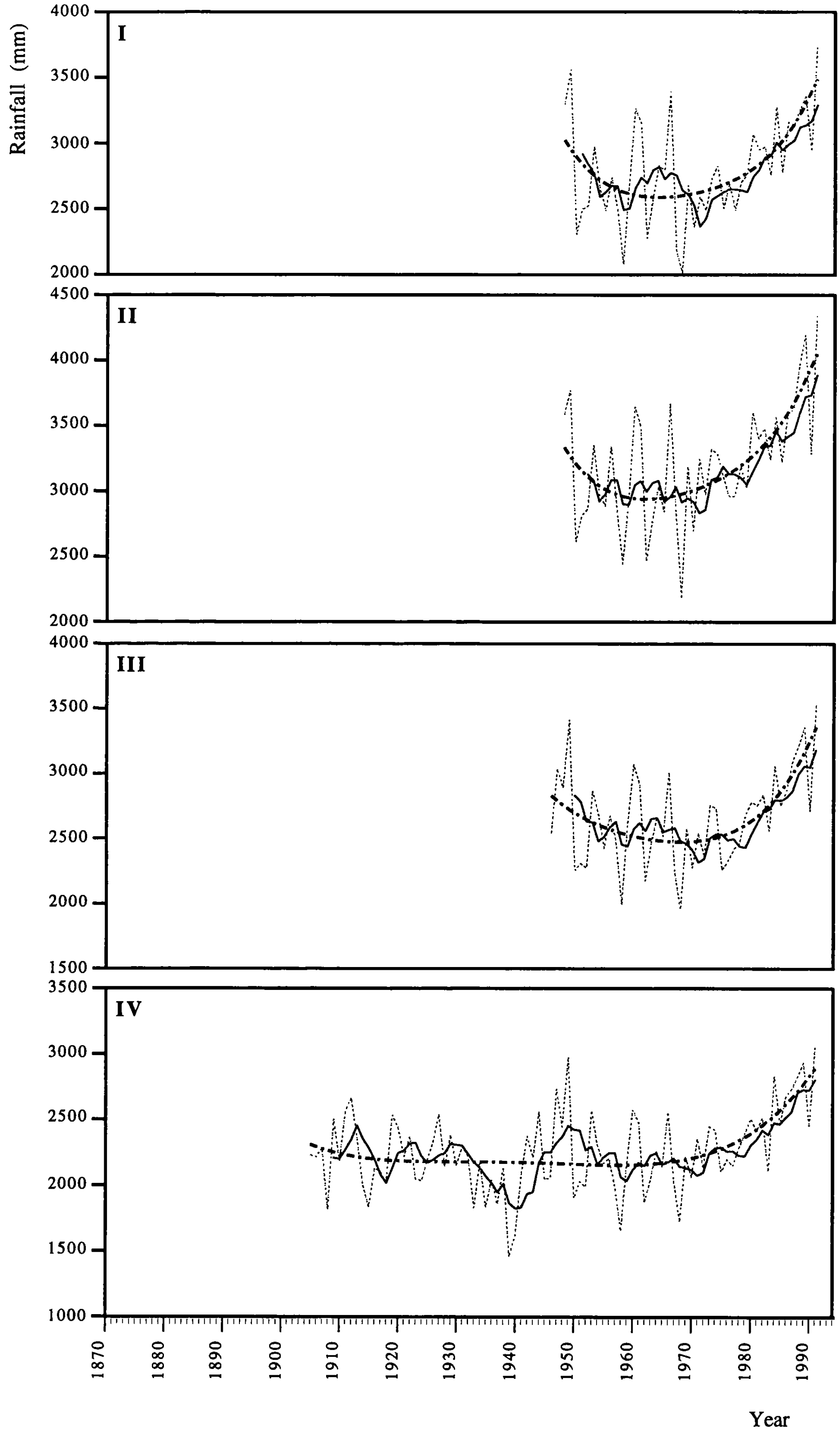

Figure 4.15: Annual (Oct–Sep) rainfall variations for the selected stations I–IV.

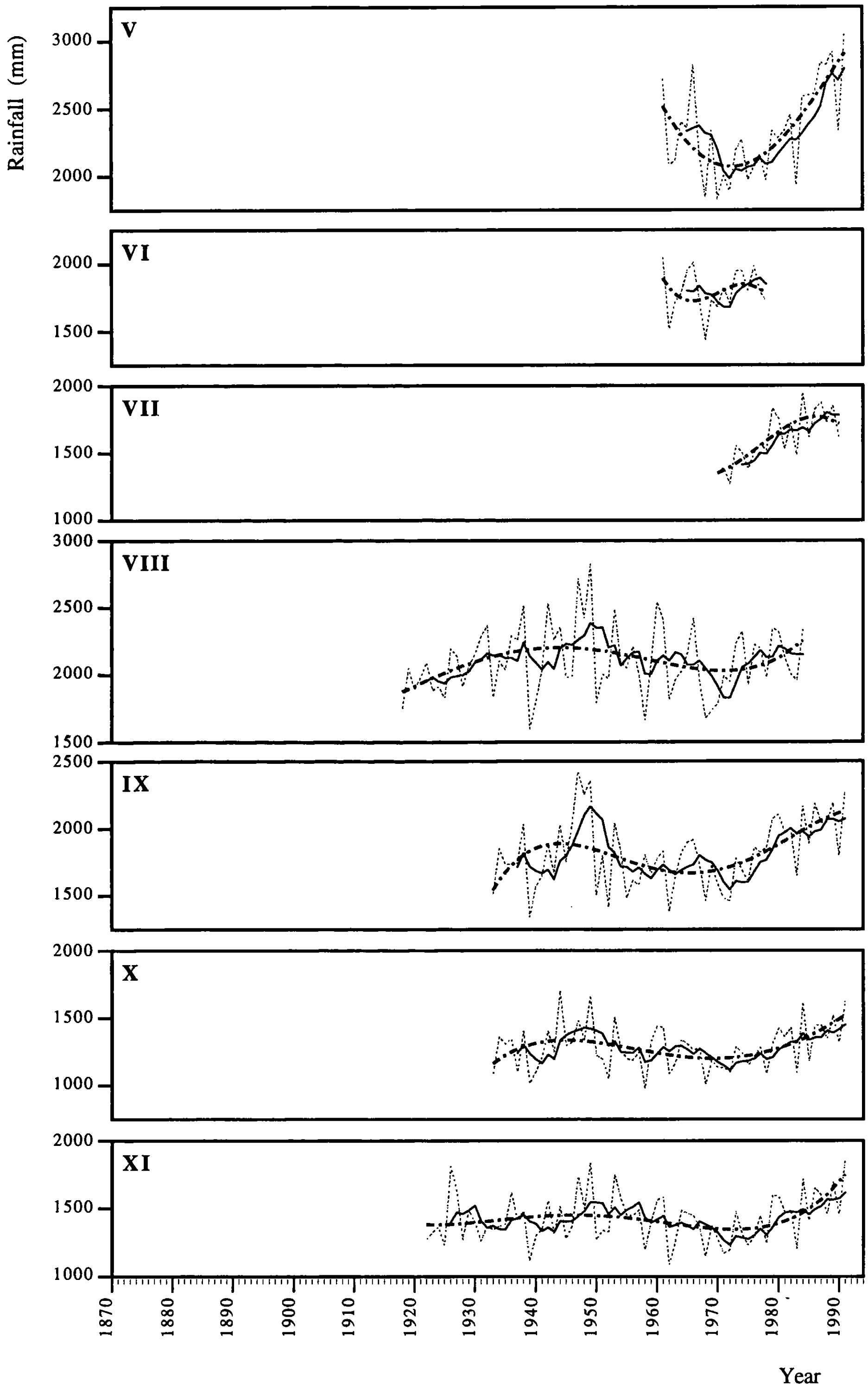

Figure 4.16: Annual (Oct–Sep) rainfall variations for the selected stations V–XI.

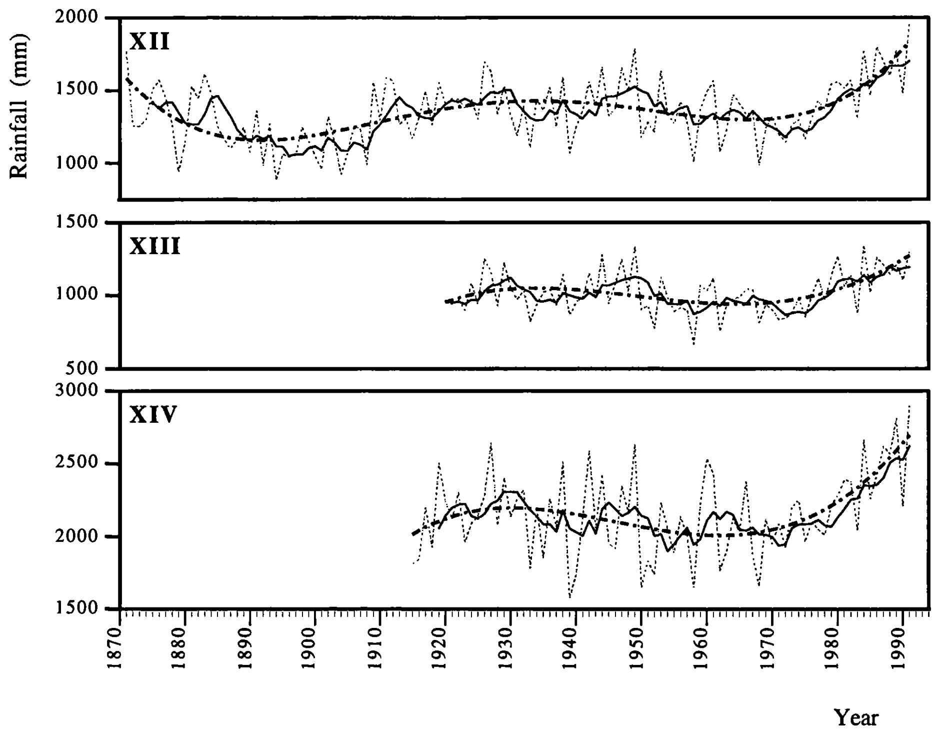

Figure 4.17: Annual (Oct–Sep) rainfall variations for the selected stations XII-XIV.

(station XIV). The increases are greatest in the North part of the basin, due to the natural greater amounts of rainfall in that area (see Figure 3.1).

The moving average line on Figure 4.15 shows the existence of rainfall fluctuations of different amplitudes over the long-term. For all stations the graphs indicate an oscillatory trend in the pattern of curves, which has been diminishing in amplitude over the last 22 years, and being replaced by a markedly increasing trend. This trend has a continuously increasing pattern and is larger than previous periods of rainfall increases. For almost all stations, the wettest year was 1991/92. Only Glasgow airport (station XIII), Blairnairn (station IX) and Balfron (station X) had wetter years in 1984/85, 1947/48 and 1944/45 respectively. There is a similar trend for the whole basin, confirmed by the control stations, but the magnitude is higher in the North and lower in the South.

Three earlier periods of increased rainfall can be identified, namely 1958/59–1965/66, 1939/40–1949/50 and 1908/09–1912/13. For the first period the increase was small, short and with a great interannual variability. This increase was not identified for the southern stations (XI, XII and XIII). The rainfall increase for the period 1939/40–1949/50 was continuous but short and was followed by weak variability. This increase was stronger for the stations IV and IX. It was in this period that Blairnairn (station IX) and Balfron (station X) registered their wettest year. The increase from 1908/09 to 1912/13 was very short and sharp with a great interannual variability. That increase is evident for the two stations (IV and XII) with records at this increasing rainfall period, but makes less of an impact on the running mean line because the measurements began in 1905.

Three major periods of decreasing of rainfall are identified, namely 1949/50–1968/69, 1927/28–1939/40 and ?–1894/95. The first period included a small decrease between 1966/67 and 1968/69, which was very short, rapid and with a great interannual variability for all stations. In the North, the overall decrease was slow, long and with great variability, which included both rainy and dry years, and the pattern is similar in the whole basin and control stations. The 1927/28–1939/40 decrease was not continuous but had a small rise (1936/37– 1938/39) and the variability was not so strong across the basin. The rainfall decrease for the period ?–1894/95, described only for station XII, was an oscillatory decrease, which brought the largest dry period recorded (1886/87–1908/09) including the driest year (1894/950) for this station.

The polynomial curves show a very similar pattern for all the stations, with the same differences in the slope of the line. The South-eastern stations (X, XI and XIII) have a lower slope for the present precipitation increase. The polynomial curve from the longest data series (station XII), is used as representative of the study area in terms of general trends and fluctuations. The long term variability (overall fluctuations) shown by the curvilinear line exhibits a long positive fluctuation, including a great number of wet years, separated by two negative fluctuations, including great number of dry years. The positive fluctuations culminate in the 30s and the negatives occurred at the turn of the century and at the end of the 60s. It must be noted that the last negative fluctuation was not so marked either in magnitude or amplitude. However, the increasing trend that became established during the 70s reached a magnitude never before reached, not only for station XII, but for all of the stations with records up to 1991/92.

4.2.2 Seasonal

The Winter half-year rainfall amounts expressed in millimetres, for the selected stations, are shown in Figures 4.18–4.20. The raw data are plotted for Winter with a light dotted line and for Summer with a light dashed line, the moving average for both Winter and

Summer with a solid line, and the polynomial curve fit with a dash dot line. In all cases the upper sets of lines relate to Winter rainfall and the lower sets to Summer rainfall

The lines of **actual values** show, for Winter and Summer, rainfall great oscillations from year to year, specially for the period between 1910/11 and 1964/65. This interannual variability is higher for Winter due to the absolute values plotted.

The most interesting trends of the Winter and Summer fluctuations are the more pronounced definition of the seasons from around 25 years ago, together with a general lower variability. Drier summers occurred until the end of 1970s, when a higher variability began along with a tendency for increasing rainfall amounts. This occurs irrespective of the line used (i.e. for actual values or smoothed lines) or whether the station is inside the basin or outside. The present differentiation of the seasons began in 1963/64 when a dry Winter and a wet Summer occurred, for several stations. The period from the beginning of the 1940s was characterised by great interannual variability, a decreasing trend in Winter amounts together with a decrease in Summer amounts to the middle of the 1950s, followed by an increase up till 1963/64. After this an increase in Winter values and a decrease in Summer values occurred. The Winter trend has continued to the present, whilst the decrease in Summer values stopped at the middle of the 1970s and has been rising since. This pattern is very similar for all the stations, but the variation in absolute terms is stronger for the northern stations.

During the period 1908/09 to 1945/46 large fluctuations occurred in Winter and Summer, but in general in opposite directions, i.e. an increase in Winter values corresponded with a decrease in Summer values (from 1908/09 to 1914/15 and from 1923/24 to the middle of 30s). On the other hand, a decrease in Winter values correspond to an increase in Summer values, namely 1914/15–1923/24 and 1940/41–1945/46. This last period, in terms of fluctuations, was more complex for station IV, where after the beginning of 30s until the end of 50s the seasonal rainfall had a similar pattern, i.e. increases and decreases are verified together. This resulted in the strong decrease (1930/31–1940/41) and the strong increase (1940/41–1950/51) in the annual rainfall amounts.

The period corresponding to the end of the past century and the beginning of the present century, with annual precipitation below the mean, was the driest in whole period of records because of the low amounts for both Winter and Summer. Before 1890, the same station, recorded a slight decrease in Winter and Summer amounts with a greater

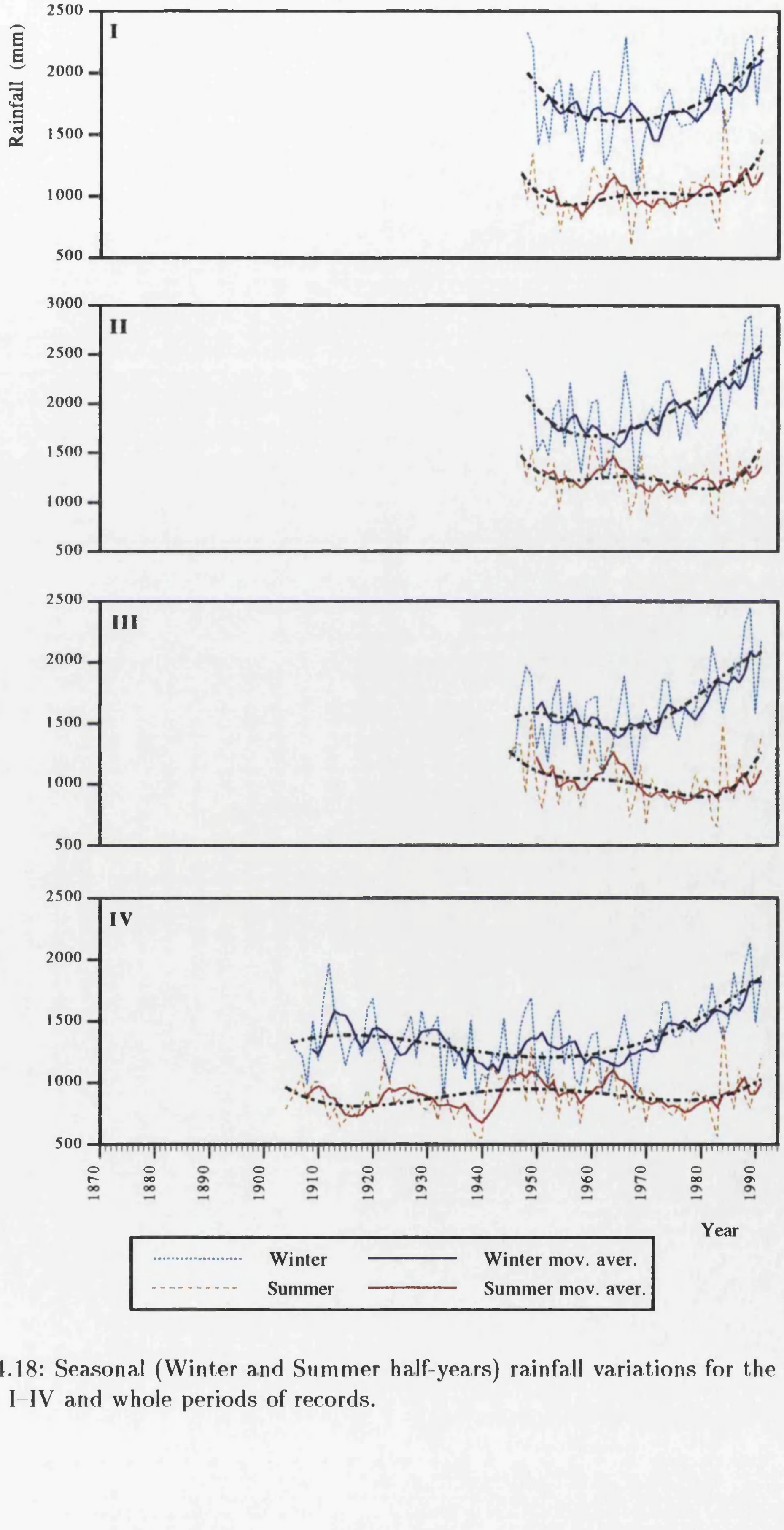

Figure 4.18: Seasonal (Winter and Summer half-years) rainfall variations for the selected stations I–IV and whole periods of records.

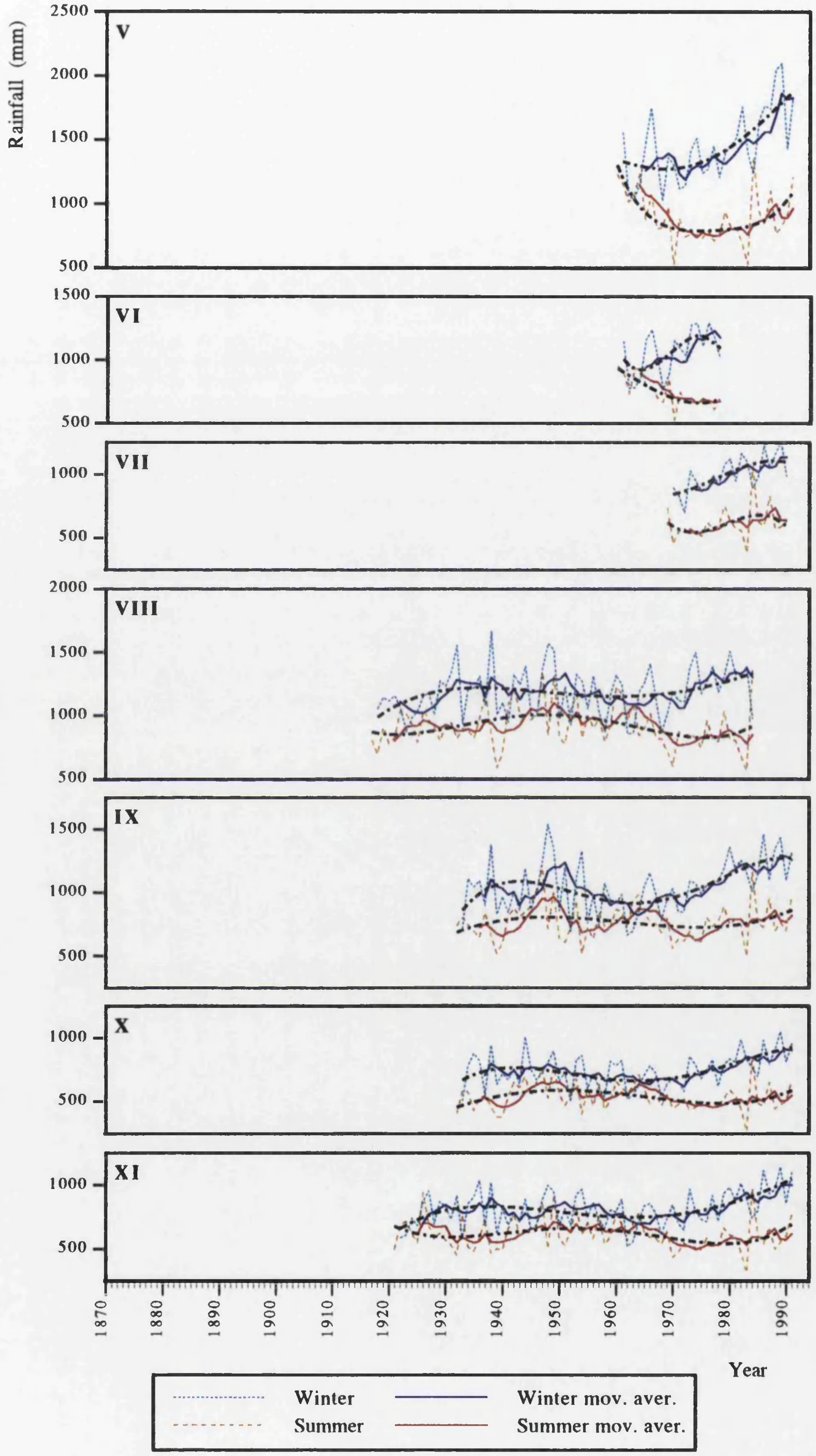

Figure 4.19: Seasonal (Winter and Summer half-years) rainfall variations for the selected stations V–XI and whole periods of records.

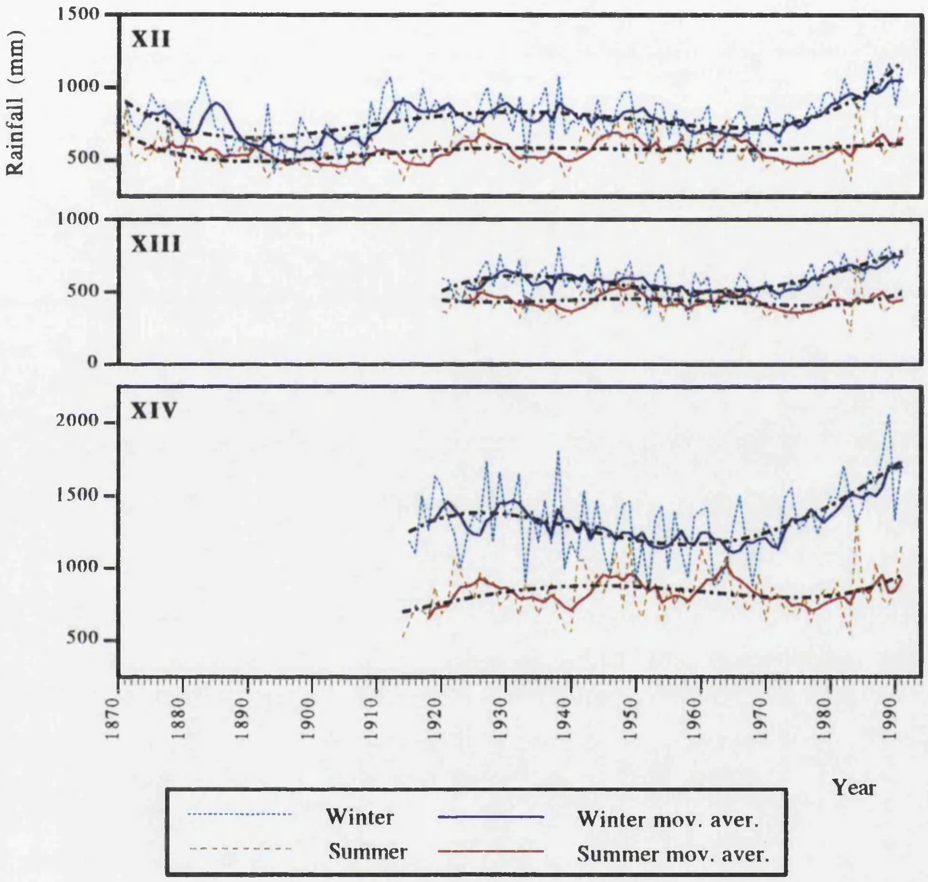

Figure 4.20: Seasonal (Winter and Summer half-years) rainfall variations for the selected stations XII–XIV and whole periods of records.

variability.

The **polynomial curve fit** shows fluctuations of great amplitude with inverse directions of Winter and Summer curves to and from the last dry period, during the 60s. Most importantly, at present, the continuous increase in Winter rainfall from the middle of 60s has been followed by only slightly increased Summer rainfall. This appears to be an anomaly in the trends.

4.2.3 Direction of the trends

The general trends for the annual, Winter and Summer rainfall amounts, for all the selected stations, can be shown by the respective regression lines in Figure 4.21–4.23. These have the disadvantage of obscuring short and medium term oscillations but do have the advantage of indicating a long trend trend (generally in excess of 50 years). These lines are shown here for comparison only and greater reliance for short and medium term should be placed on the polynomial fits rather than the regression line. Regression lines are included here only to give an impression of general trends but also to allow direct comparison with the published literature where regression lines are frequently used for this purpose.

In general terms, increasing trends are identified for annual and Winter values for all the stations, whilst the Summer trends reveals a temporal decrease for 8 of the stations and a temporal increase for 7 of the stations. Regardless of the greater slope in the trend lines of the stations with shorter series, they cannot be ignored as they reflect well the most recent increasing trend. The long term trend is shown by Helensburgh (station XII).

4.3 Spatial pattern (distribution)

4.3.1 Average annual rainfall for the periods: 1916–50; 1941–70 and 1961–90

The spatial patterns of 35 or 30 years average annual rainfall for standard periods of 1916–50, 1941–70 and 1961–90 are described in the present section. The period of 35 years was used in the United Kingdom before the adoption of 30 years period "at the 1935 Conference of the International Meteorological Organization (forerunner of the present W.M.O.)" [Lamb, 1982].

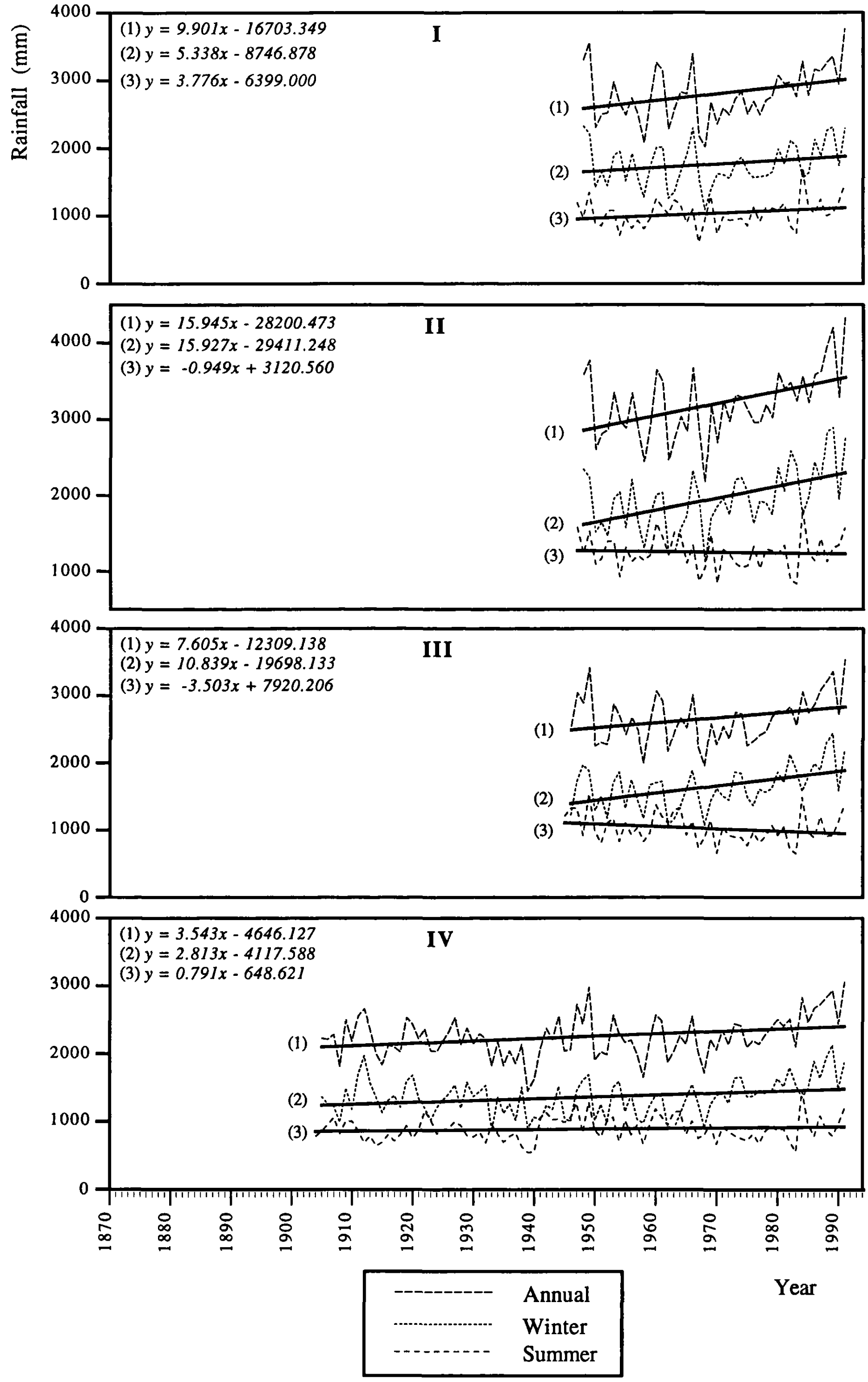

Figure 4.21: General trends of annual and seasonal rainfall, for the selected stations I–IV and whole periods of records.

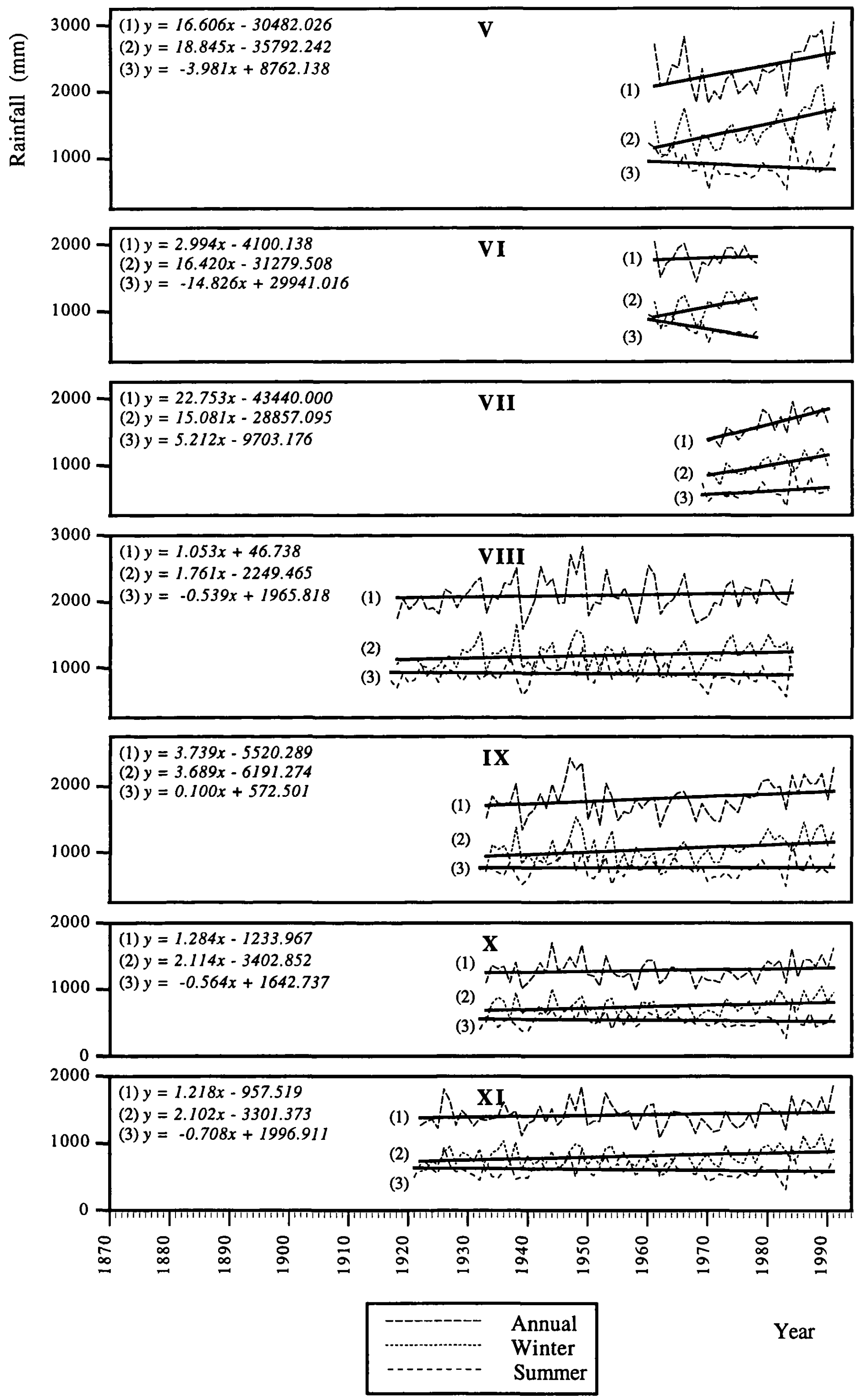

Figure 4.22: General trends of annual and seasonal rainfall, for the selected stations V–XI and whole periods of records.

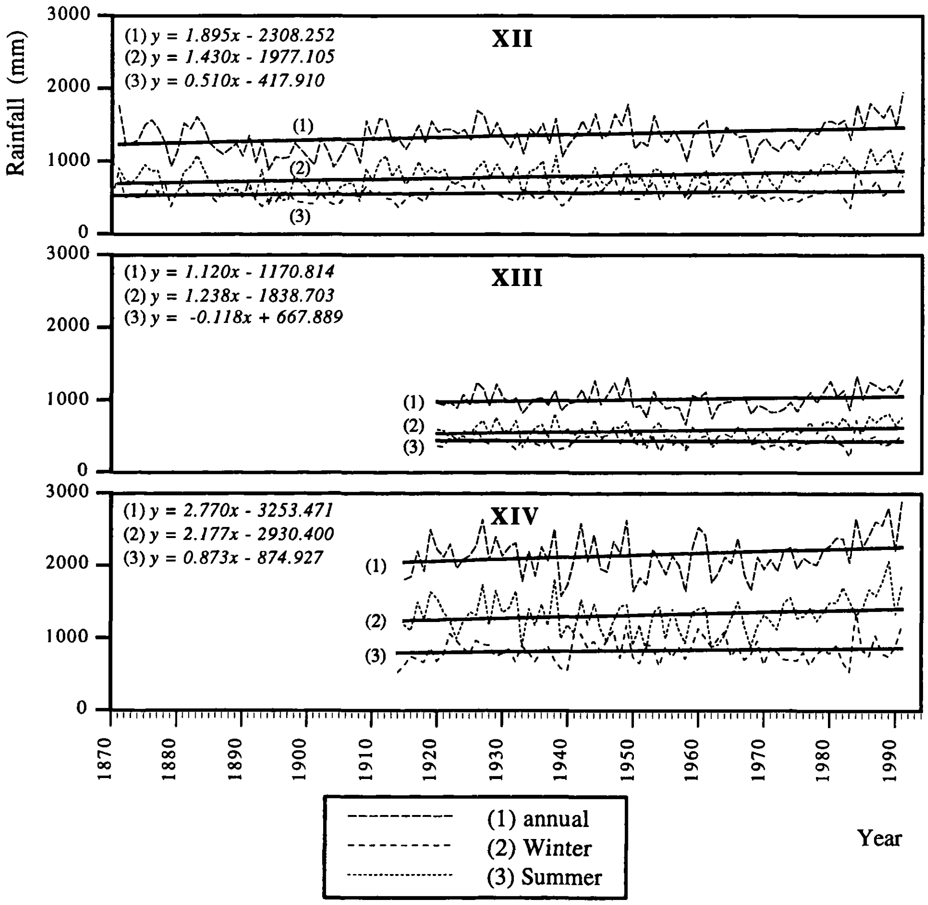

Figure 4.23: General trends of annual and seasonal rainfall, for the selected stations XII–XIV and whole periods of records.

Table 4.6 shows the annual rainfall averages, by calendar years and millimetres, for the three periods and for all the stations in the Loch Lomond catchment area [MetOffice, 1992; MetOffice, 1993]. Some stations (64, 69, 70, 71, 74, 75, 76, 77 and 78) located outside of the basin area were also included in order to highlight possible edge effects during the process of data interpolation for plotting purposes. The station numbering used during the study is also presented, as well the National Grid Reference (N.G.R.) and the altitude in metres. In order to quantify the rainfall variation from period to period the percentage of variation was calculated.

The averaged values were plotted for the three periods on a base map, together with the relief, the station site and the catchment area boundary. The network of stations used is slightly different from map to map consonant with data availability. Isohyets were drawn, using the isohyetal method, representing the average of annual rainfall, at intervals of 200mm, from 1400 to 3900mm. Intermediate isohyets of 1300 and 1500mm were included due to the lower gradient in the areas with less average rainfall. Averages of 2000, 3000 and 4000mm are shown as very solid lines. The isohyet intervals are shorter than those recommended by W.M.O. in order to better describe the spatial rainfall variability in a small study area. Nevertheless, the intervals recommended by W.M.O. are highlighted on the map legends.

The average annual rainfall for the study area in the period 1961–90 is shown in the Figure 4.24. The most evident spatial patterns are that the Northwest part of the basin received on average larger quantities of rainfall and has a greater spatial variability than the Southeast part. On average the station which receives greatest amounts of rainfall is Beinn Ime, South (station 17) with 3814mm, whilst Killearn Hospital (station 56), in the middle of the Endrick Water basin, has an average of 1244mm. The contrast in variability is illustrated by the gradient extremes, which are 256mm of precipitation per Km from Beinn Ime, South to Inveruglas, and 30mm of precipitation per Km from Luss to Killearn Hospital. In the Southwest part of the basin the 1800mm isohyet marks a spatial change in the rainfall gradient, while in East the transition is noted by the isohyet of 2200mm. Another aspect relative to the spatial variability, it is that northwards along the Loch, the rainfall quantity rises, but with a gradient of 42mm of precipitation per Km, similar to the southern area. The rainfall received directly into the Loch, over the northern part, between Ben Vorlich and Beinn Choin, to Inveruglas is on average from 2600 to 2800mm

Code RSTNNO	Selected Stations	St. No	Name	N. G. R. East	N. G. R. North	Alt. (m)	average annual rainfall (mm) 1916-50	1941-70	% var.	1961-90	% var.
661562		1	Keilator	2368	7244	229	2616	2400	-8.3	2389	-0.5
661777		2	Allt Nan Caorrunn	2278	7222	366	3021	2760	-8.6	2763	0.1
661778	I	3	Allt Nan Caorrunn	2277	7220	341	3020	2780	-7.9	2764	-0.6
661807	I	4	Dubh Eas	2291	7203	369	3108	3082	-0.8	3299	7.0
661882	II	5	Lairig, Arnan	2295	7181	340		3106		3266	5.2
661883	II	6	Lairig, Arnan	2295	7182	340	3197	3114	-2.6	3240	4.0
661901		7	Inverarnan	2317	7185	18	2667	2600	-2.5	2701	3.9
661912		8	Dubh Uisge	2285	7152	323	3200	2907	-9.2	3218	10.7
662014		9	Ardvorlich	2315	7116	342	3179	3142	-1.2	3110	-1.0
662041	III	10	Sloy Power Sta. No.1	2324	7099	12	2699	2618	-3.0	2659	1.6
662042	III	11	Sloy Power Sta. No.2	2321	7098	12	2700	2618	-3.0	2646	1.1
662043		12	Sloy Power Sta. Mter.	2321	7098	12		2618		2642	0.9
662065		13	Loch Sloy, Cam Allt	2266	7143	482		3078		3129	1.7
662077		14	Allt A'Chnoic	2255	7140	411	3292	3198	-2.9	3321	3.8
662118		15	Sloy Main Adit	2293	7105	204	3135	3150	0.5	3196	1.5
662119		16	Sloy Main Adit	2293	7104	204	3137	3150	0.4	3206	1.8
662130		17	Beinn Ime, South	2270	7080	381	**3574**	3696	3.4	**3814**	3.2
662131		18	Beinn Ime, South	2270	7082	403	3496	**3700**	5.8	3764	1.7
662142		19	Beinn Ime, North	2266	7093	467	3529	3523	-0.2	3744	6.3
662163		20	Coiregrogain	2300	7093	137		2930		2825	-3.6
662173		21	Inveruglas	2320	7091	13		2600		2662	2.4
662208		22	Corriearklet	2382	7099	290	2278	2300	1.0	2151	-6.5
662214	IV	23	Corriehichan	2376	7085	198	2261	2262	0.0	2356	4.2
662216	IV	24	Loch Arklet, Corriehichan	2372	7084	265				2358	
662239	IV	25	Corriehichan	2371	7084	265	2261	2300	1.7	2391	4.0
662343		26	Rowchoish	2343	7050	168	2286	2450	7.2	2323	-5.2
662454		27	Ardess	2360	6994	18	2161	2047	-5.3	2087	2.0
662484		28	Glen Douglas	2276	6999	146		2600		2457	-5.5
662549	V	29	Doune	2313	6981	98	2563	2400	-6.4	2453	2.2
662588	V	30	Inverbeg	2344	6981	46	2032	2080	2.4	2164	4.0
662838	VI	31	Sallochy	2387	6955	47	1925	1858	-3.5	1947	4.8
662851		32	Cashell Burn	2418	6954	334	2096	2037	-2.8	2125	4.3
662984	VII	33	Arrochymore	2415	6918	30	1778	1600	-10.0	1591	-0.6
662985		34	Arrochymore Logger Sta.	2413	6918	30		1600		1603	0.2
663046	VIII	35	Glen Finlas Resr. South	2329	6893	221		2200		2210	0.5
663047		36	Glen Finlas Resr. No.1	2328	6883	238	2286			2209	
663048	VIII	37	Glen Finlas Resr. No.2	2330	6895	247	2286	2200	-3.8	2219	0.9
663121		38	Auchengaich Resr, North	2276	6918	244	2300	2030	-11.7	2003	-1.3
663124		39	Auchengaich Resr, South	2275	6915	244	2261	1990	-12.0	1991	0.1
663174		40	Ballevoulin	2295	6885	137	2032	1750	-13.9	1802	3.0
663180		41	Blairnairn No.3	2308	6894	482	2140			2158	
663181		42	Blairnairn No.2	2308	6888	381	2032			1823	
663182	IX	43	Blairnairn No.1	2302	6882	175	1884	1786	-5.2	1812	1.5
663366		44	Endrick Weir	2682	5867	238	1559	1511	-3.1	1568	3.8
663433		45	Lurg Forest	2627	6846	305		1700		1805	6.2
663462		46	Fintry	2616	6870	91	1522	1502	-1.3	1464	-2.5
663569		47	Mount Farm	2586	6873	107		1400		1464	4.6
663632	X	48	Old Ballikinrain	2559	6879	65	**1314**	1295	-1.4	1345	3.9
663672	X	49	Balfron High Sch.	2549	6891	104		1294		1304	0.8
663675	X	50	Balfron, Old Stables	2541	6886	53		1270		1277	0.6
663688	X	51	Balfron, the Old Manse	2542	6890	82	1397	1300	-6.9	1271	-2.2
663703		52	Killearn,the Oaks	2522	6862	76				1314	
663787		53	Blanefield	2555	6796	76	1404	1399	-0.4	1419	1.4
663840		54	Quinloch Farm	2518	6820	30		1350		1388	2.8
663867		55	Killearn S. Wks	2518	6844	23		1270		1292	1.7
663913		56	Killearn Hosp.	2509	6850	23	1350	**1252**	-7.3	**1244**	-0.6
663926		57	Burncrooks Resr	2490	6796	251	1500	1610	7.3	1572	-2.4
663931		58	Burncrooks Res.	2483	6795	252	1389	1600	15.2	1591	-0.6
664010		59	Drymen, Muir Park	2488	6919	201	1567	1528	-2.5	1573	2.9
664142		60	Drymen, Park of Drumq.	2483	6869	20		1258		1306	3.8
664254		61	Gartocharn	2425	6857	45	1447	1353	-6.5	1382	2.1
664462	XI	62	Loch Lomond Park	2391	6832	56	1496	1423	-4.9	1415	-0.6
664469	XI	63	Loch Lomond Park	2391	6831	48				1401	
664585		64	Renton, Carman Filters	2383	6788	89	1259	1250	-0.7	1290	3.2
664975	XII	65	Helensburgh	2303	6837	96		1420		1441	1.5
664976	XII	66	Helensburgh	2303	6836	89	1463	1416	-3.2	1429	0.9
659049	XIII	67	Renfrew, Met. Office	2508	6663	8				959	
660285	XIII	68	Abbotsinch, Met. Office	2480	6667	5		991		1035	4.4
881872		69	Upper Glengyle	2361	7148	229				2481	
891909		70	Glengyle	2388	7133	119				2348	
891986	XIV	71	Stronachlachar	2401	7103	117		2149		2202	2.5
891990	XIV	72	Stronachlachar, Invergyle	2401	7103	115				2216	

Table 4.6: Average annual rainfall for the periods: 1916–50; 1941–70 and 1961–90.

and over the very South is around 1500mm.

Figure 4.25 represents the map of the average annual rainfall for the period 1941–70, produced in the same way as the map of the period 1961–90. The same basic patterns occur over the basin for these two periods. However, there are differences, not in the general distribution, but in the rainfall averages, which are reflected in differences in the gradients. For the area between station 17 and 21 the gradient was 243.5mm of precipitation per Km, which means an increase of 12.5mm per Km from 1941–70 to 1961–90. In the South-east, for the area between station 56 and 34 the gradient was 29.6mm per Km, discerning a positive but slight increase of 0.9mm per Km. The spatial variability, along the Loch, from the southernmost (station 61) to northernmost (station 7) was 36.4mm per Km for the 1941–70 averaged rainfall, therefore the increase was 2.1mm per Km.

For the period of 1916–50 a similar pattern for average annual rainfall is shown in the map (Figure 4.26). However, significant differences in quantities and hence in spatial variability (lower) can be seen. It must be pointed out that the upper extreme average for Beinn Ime, South, is lower and the lower extreme average, for Old Ballikinrain, is higher than for two later periods later on time (see Table 4.6). Concerning the gradients for the prior considered areas it is greatest value occurs at the slope Beinn Ime-Inveruglas where it varies 194.3mm per Km, which means an increase of 49.3mm per Km from 1916–50 to 1941–70. Between station 56 and 34, on the other hand, the average rainfall varies 36.4mm per Km, although a decrease of 6.8mm per Km occurred up to 1941–70. Along the Loch the gradient was 35.6mm per Km and the variation to the later period (1941–70) was 0.8mm per Km.

The spatial patterns for the three standard periods described show that the increase in average rainfall occurred over the whole area in general. The highest rainfall contour plotted increased from 3600mm to 3800mm to 4000mm over the periods 1916–50, 1941–70 and 1961–90 respectively. In the higher stations and in the northern of the basin the increase was greater in terms of the spatial variability of rainfall. In other words, the Northwest became increasingly rainy whilst the Southeast has similar, or in some cases, even lower average rainfall over this period of years.

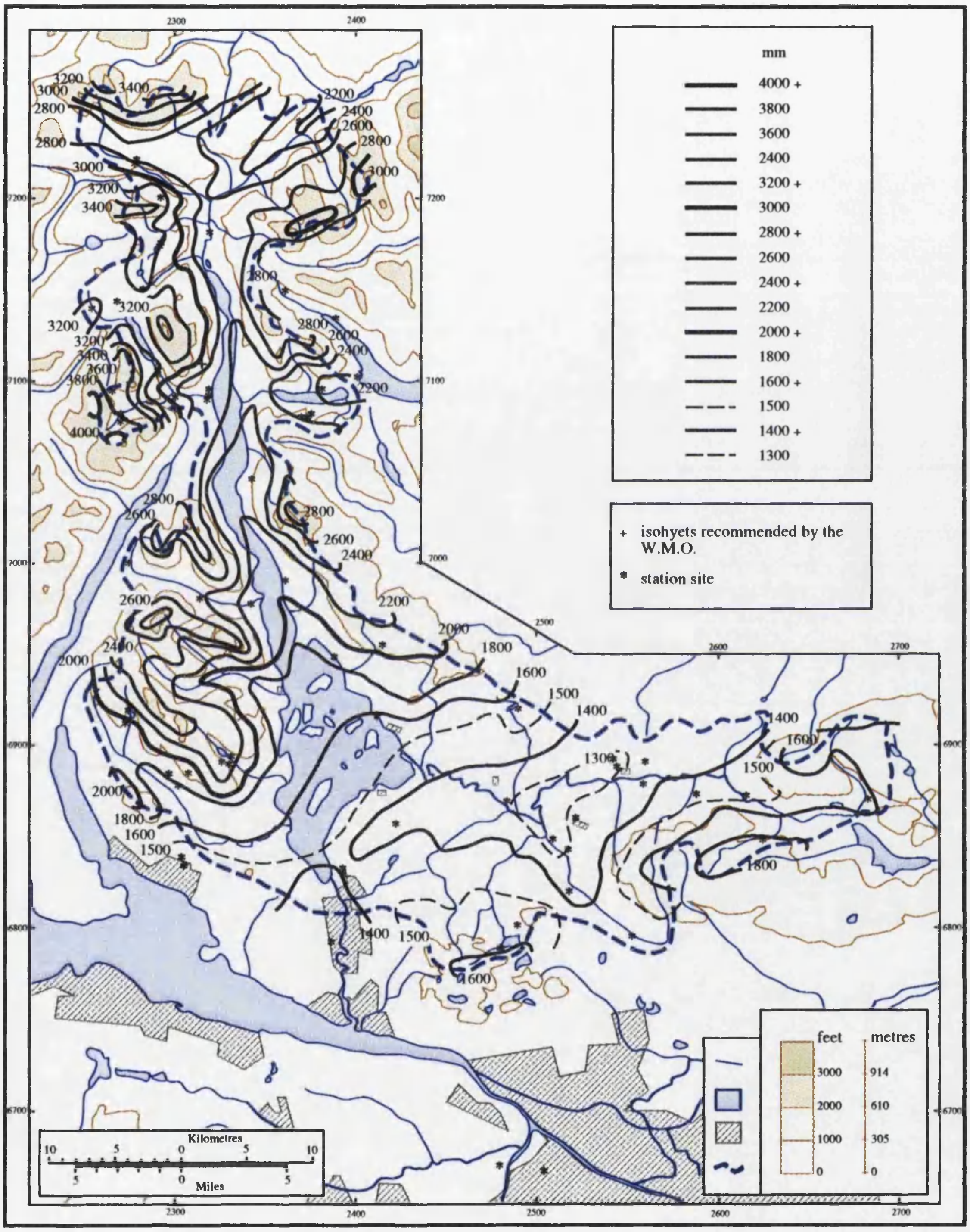

Figure 4.24: Average annual rainfall patterns for the period 1961–90.

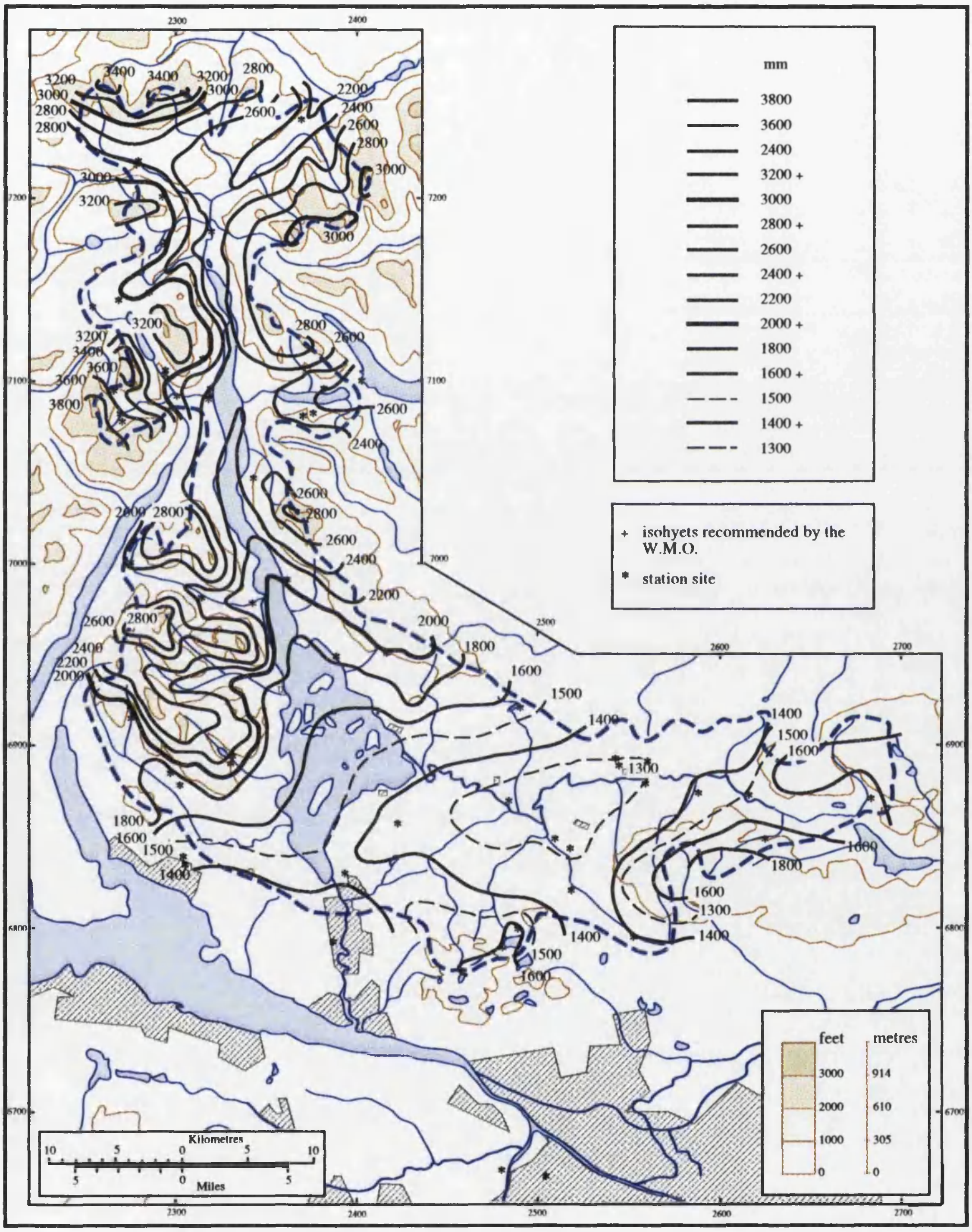

Figure 4.25: Average annual rainfall patterns for the period 1941–70.

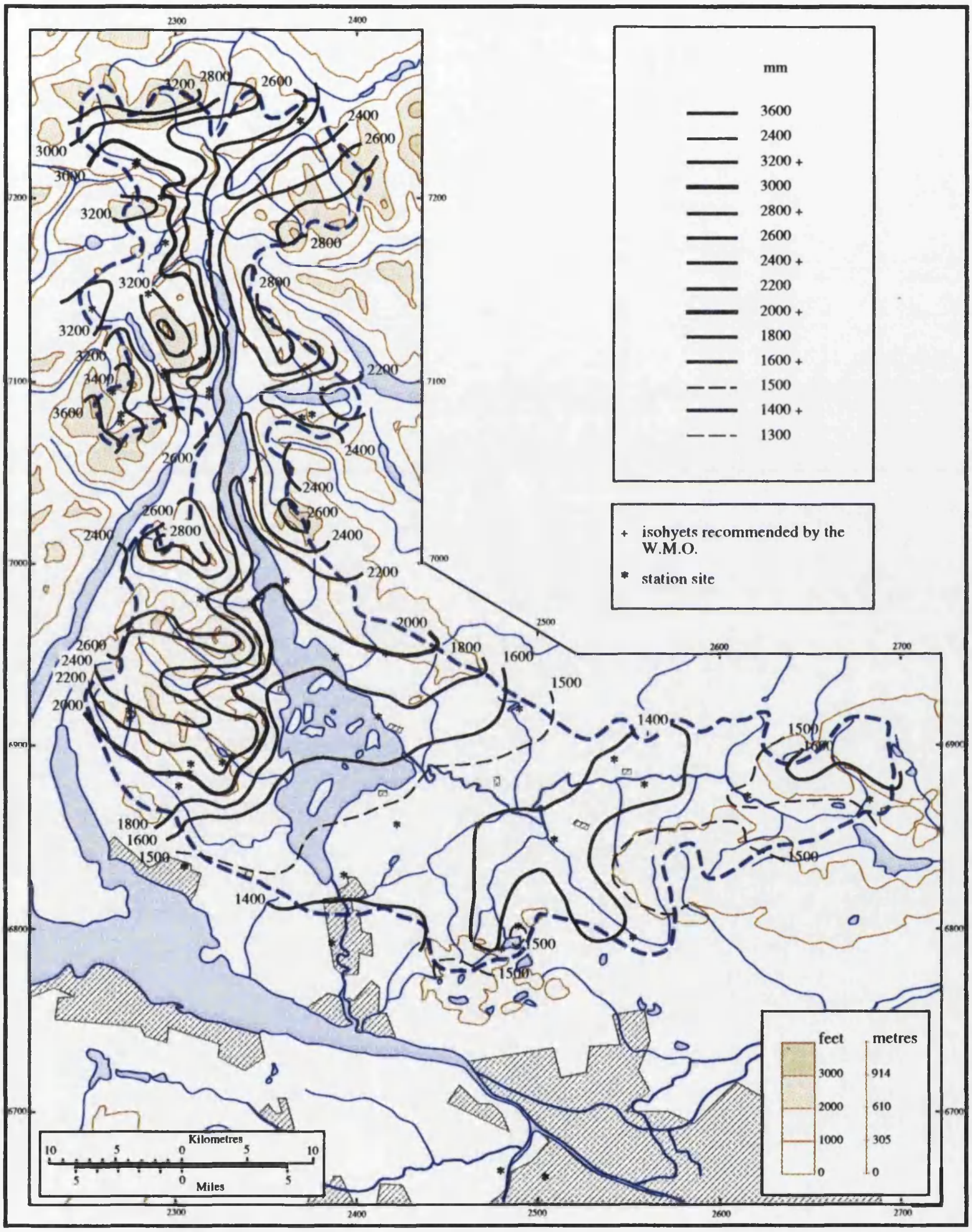

Figure 4.26: Average annual rainfall patterns for the period 1916–50.

Chapter 5

Discussion

Analysis of the annual and seasonal rainfall variability and trends in the short and long term in the Loch Lomond basin indicate that important fluctuations and trends in rainfall have occurred over the time period analysed here. The most important of these is the increasing rainfall trend over the last two decades and, in view of the potential for an enhanced greenhouse effect, growing concern may centre on this trend in the future.

This chapter is intended to give an interpretation of the results by summarising what they show, comparing them with results at wider scales and examining them in the light of wider atmospheric circulation patterns. The wider implications of increasing rainfall in the Loch Lomond basin are also discussed. Finally, in the last section of this chapter, the methodology used in the analysis is discussed.

5.1 Trends in rainfall patterns in the Loch Lomond catchment area: long and short term variability

This section is concerned with an interpretation of the results for annual and seasonal rainfall variability, trends and fluctuations and average annual rainfall spatial patterns. The results are summarised and followed by comparisons with other studies and by an interpretation of the general variations identified in the Loch Lomond catchment area.

5.1.1 Annual and seasonal rainfall variability

The main findings from the annual and seasonal rainfall variability analysis for the Loch Lomond basin are assessed and compared with other wider spatial scale variability studies.

This work has demonstrated that the largest period of rainy years over the Loch Lomond basin has occurred since 1984/85, together with an increasing trend in annual rainfall amounts from 1968/69 to 1991/92. It is also important to note that from 1979/80 to present the annual rainfall amounts were above the mean, with higher percentages each year, except the dry year of 1983/84. The wettest year, for almost all stations, was 1991/92. The recorded data showed only one other wet period, from 1942/43 to 1949/50, while it showed three dry periods: 1967/68 – 1978/79; 1933/34 – 1940/41 and 1887/88 – 1908/09. The period 1887/88 – 1908/09 was the driest and it includes the driest year of all: 1894/95. No extremely rainy or dry years (excess of 3SD above and bellow the mean) occurred during the studied period.

These temporal fluctuations have affected the whole basin, however the variability in absolute terms is higher for the North-western stations.

Concerning the seasonal rainfall variability it is relevant that no dry Winter half-years occurred during the last twenty years whilst rainy winters were more frequent. The wettest Winter was 1989/90 for most of the studied stations whilst the driest Winter was 1894/95 for the longest record and 1962/63 or 1968/69 for the others. Summer half-years registered a higher rainfall variability for the same period, with the extremes of all records, the driest Summer (1984) and the wettest Summer (1985). A variation of between 79% to 111% occurred for the studied stations within the basin. This was the greatest interannual variability identified.

For the longest rainfall records (station XII – Helensburgh) it was possible to detect that before 1981/82, wet winters occurred every 30 or 40 years as did the driest winters. After 1981/82, wet winters have been occurring every 4, 3 and 2 years and no dry winters occurred in this period. A higher frequency of rainy winters was registered after 1973/74.

Summer half-years showed a higher variability in the last 20 years. For Helensburgh, wet summers tend to occur more frequently (55 years, 30 years and 7 years) and dry summers tend to occur less frequently (14 years, 25 years and 44 years). The higher frequency of rainy summers is relatively recent (after 1985). This contradicts some of the studies which predict a tendency towards drier summers over Great Britain [Arnell *et al.*, 1990]. Other model's results also indicate wetter summers and concluded that "the best estimate is probably no change" [CCIRG, 1990]. Further research about this recent tendency in the Loch Lomond area and comparisons with other areas of Scotland, England and Wales is necessary. It is also important to set the above pattern against the evolution of general atmospheric circulation patterns during the seasonal half-years. The trend could be a result of the seasonal period studied, since some wider results are done by using the traditional four seasons, and this may affect the trend to wetter springs. This aspect also needs further investigation because of its importance to decision making in terms of water resources and general changes.

Changes in rainfall variability are less studied than means and trends, but studies of extreme rainfall events have demonstrated increases in frequency and intensity and associated rises in flood frequency events (see Section 2.1.3)[1]. This is more important as "in developing climate change predictions high priority should be given to changes in extremes" [CCIRG, 1990]. In general terms we must consider that "climate perturbation" like changes in rainfall variability "would have as great an influence as a change in mean" [Rind *et al.*, 1989] and an examination of "how the frequency of extreme events might change as the mean climate changes" are needed [Katz and Brown, 1992]. Rind et al. (1989) presented the primary results of their study to attempt to find the nature of temperature and rainfall variability and mean relationship of change. They concluded that "on a broader area, the sign of the change is significant, with temperature variability decreasing and precipitation variability increasing (as mean precipitation increases)" [Rind *et al.*, 1989].

The results of the present study in terms of precipitation variability and mean are consistent with this wider scale study. Thus that sign of variability change in Loch Lomond area could be an indicator of general climate change.

5.1.2 Annual and seasonal rainfall trends and fluctuations

The main findings from the annual and seasonal rainfall trends and fluctuations analysis for the Loch Lomond basin are assessed and compared with results from other studies, particularly for Scotland, the UK and Europe.

[1]The wider implications of increasing rainfall will be specified later in Section 5.2.

Temporal analysis for annual and half-yearly rainfall amounts in the Loch Lomond basin has demonstrated a long term increasing trend for annual and Winter rainfall amounts in all selected stations. Summer rainfall amounts have an increasing trend in stations I, IV, VII, IX, XII and XIV, whilst a general decreasing trend for Summer rainfall amounts is shown in stations II, III, V, VI, VIII, X, XI and XIII. These general increases are a result of the substantial recent increase, especially in the North.

	Annual			Winter			Summer		
Station	1968/69	1991/92	% var.	1968/69	1991/92	% var.	1969	1992	% var.
I (NW)	2017.4	3759.6	86.4	1085.8	2295.2	111.4	931.6	1464.4	57.2
II (NW)	2179.4	4340.4	99.2	1127.3	2768.7	145.6	1052.1	1571.7	49.4
III (NE)	1958.3	3536.2	80.6	1070.3	2167.7	102.5	888.0	1368.5	54.1
IV (NW)	1727.2	3063.0	77.3	913.1	1868.0	104.6	814.1	1195.0	46.8
V (W)	1842.0	3045.3	65.3	1023.7	1835.7	79.3	813.3	1209.6	48.7
IX (SW)	1460.8	2284.0	56.4	780.0	1314.0	68.5	680.8	970.0	42.5
X (SE)	1008.4	1619.1	60.6	538.5	902.0	67.5	469.9	667.4	42.0
XI (S)	1147.1	1864.2	62.5	610.0	1095.4	79.6	537.1	768.8	43.1
Mean	**1667.6**	**2939.0**	**76.2**	**893.6**	**1780.8**	**99.3**	**773.4**	**1151.9**	**49.0**
XII (SW)	984.6	1951.5	98.2	487.1	1147.9	135.7	497.5	803.6	61.5
XIII (S)	815.0	1296.0	59.0	421.0	770.0	82.9	394.0	526.0	33.5
XIV (NE)	1653.5	2898.3	75.3	880.4	1736.6	97.3	773.2	1161.7	50.2

Notes:
1 Station VII do not have records for 1968/69
2 Stations VI and VIII do not have records for 1991/92
3 Control stations: XII, XIII and XIV

Table 5.1: Annual, Winter and Summer half-yearly percentage of rainfall increases (1968/69–1991/92) in the Loch Lomond basin.

Data analysis has also revealed periodic increasing and decreasing trends, from which the most important is the markedly increasing trend in annual rainfall during the last 25 years. This increase in rainfall reached a magnitude never registered before for the basin, with the increases higher in magnitude for the Northern stations. This aspect is clearly visible in Table 5.1, which presents annual, winter and summer variations from the last dry period (base year of 1968/69) to the present time (1991/92) over the Loch Lomond basin and control stations (XII, XIII and XIV). This change in annual precipitation totals could be interpreted as a trend or part of a larger fluctuations. The Scotland area-average annual series from Gregory et al. show also a "decadal time-scale upward trend" (see Figure 2.8) which "cannot be regarded as unusual in the context of longer time-scales" [Gregory *et al.*, 1991]. Nevertheless the authors have used series from 1930 up till 1989 by calendar year. In the same work, for England and Wales and for Northern Ireland, no trend is visible and the fluctuations are smaller.

The annual upward trend in the rainfall of the Loch Lomond area is essentially a result of a rapid and continuous Winter rainfall increase starting 25 years ago. Together with a Summer rainfall decrease up till the end of the 70s, followed by a modest increase, contributed to a more pronounced definition of the seasons in terms of rainfall. Prior to that increase large fluctuations have occurred either for annual or seasonal amounts, as follows:

- increases in annual rainfall:
  - 1958/59–1965/66
  - 1939/40–1949/50
  - 1908/09–1912/13;
- decreases in annual rainfall:
  - 1949/50–1968/69
  - 1927/28–1939/40
  - ... –1994/95;
- increases in Winter rainfall:
  - 1963/64– ...
  - 1923/24–mid 1930s
  - 1908/09–1914/15;
- decreases in Winter rainfall:
  - beginning of the 1940s–1963/64
  - 1914/15–1923/24
  - before 1890;
- increases in Summer rainfall:
  - mid 1950s–1964

  - 1941–1946
  - 1915–1924;
- decreases in Summer rainfall:
  - 1964–mid 1970s
  - beginning of the 1940s–mid 1950s
  - 1924–mid 1930s
  - 1909–1915
  - before 1890.

From the above sets of data, long term fluctuations are identified by polynomial curve fitting as follows:

- wet periods of annual rainfall:
  - increasing after 1970s
  - 1940s
  - 1930s
  - 1920s;
- dry periods of annual rainfall:
  - end of 1960s
  - 1900s
  - 1890s;
- wet periods of Winter rainfall:
  - increasing after 1970s
  - 1914/15–1940s;
- dry periods of Winter rainfall:
  - 1960s
  - 1900s

  - 1890s;

- wet and dry periods of Summer rainfall:

  - slight variations

  - no defined trend;

The actual increasing trend in annual rainfall amounts over the Loch Lomond area is consistent with the prediction of a global precipitation change if the CO_2 concentration doubled [Goodess *et al.*, 1992].

5.1.3 Average annual rainfall spatial patterns

The main findings of the average annual rainfall spatial patterns, over the Loch Lomond basin analysis are summarised below, followed by comparisons with wider spatial scale rainfall patterns.

Analysis of the average annual rainfall for three periods (1916–50; 1941–70 and 1961–90) in the Loch Lomond basin has revealed important changes in rainfall.

A general feature in the rainfall over the study area is a general reduction in the rainfall quantities from the Northwest to Southeast, which was also indicated by the time-series analyses both for annual and seasonal amounts. Moreover, the Northwest part of the basin has a greater spatial rainfall variability than the Southeast which can be noticed by the gradient of 256mm/Km and 30mm/Km respectively. This are clearly showed by the isohyets of Figures 4.24, 4.25 and 4.26.

Related to the variations of average annual rainfall between the three periods considered, the same basic spatial patterns occur within the basin. However a trend of rainfall increase over time is noticed, which is greater for higher stations. Thus, the Northwest is becoming increasingly wetter and the Southeast is more steady or even drier (e.g., in the middle of Endrick Water basin).

5.1.4 Possible causes of increasing rainfall

The trend of increasing rainfall over the last 20-25 years in the Loch Lomond basin together with a relatively increasing variability in the Summer half-years is possibly related to "a regional trend to more frequent westerly airstreams over Scotland" [Mayes, 1991].

These results have shown that the rainfall trends between the Loch Lomond area, the UK and western Europe are in general agreement and even at a global scale there appears to be a rainfall trend of increasing rainfall variability and increasing average rainfall [Rind *et al.*, 1989].

The changes in climatic conditions over Scotland are "a consequence of three important interacting factors": the critical position of Scotland "in relation to the interplay of the three principal conflicting air masses (Cold Polar, Cool Continental and North Atlantic, and warm Tropical Maritime) and the oceanic currents of the northwest coast of Europe [its] higher latitude than the rest of Britain [...] and [...because] it is a largely upland montane area" [Tivy, 1983]. These important climatic factors give Scotland a special sensitivity to climatic changes, particularly related with variations in atmospheric circulation. Because of this Mayes (1991), discussing patterns of regional airflows over the British Isles, came to the conclusion that the general increase in Scottish rainfall is a result of a much greater frequency of westerly activity over Scotland since the mid-1970s.

The increase in rainfall in mid and high latitudes has been related by some to global warming, which induces an increase in water vapour. Water vapour increase "produces an increase in the transport of moisture into high latitudes, giving enhanced moisture, convergence and precipitation" [Mitchell, 1990]. On the other hand, the 1990 report of the Working Group I to the IPCC suggests that "mid-latitude storms will weaken or change their tracks, and there is some indication of a general reduction in day-to-day variability in the mid-latitude storm track in Winter in model simulation." The mid-latitude storm tracks across the North Atlantic, which are driven by the equator-to-pole temperature contrast, will probably be weakened in a warmer world. The possible variations in atmosphere circulation brought a general concern as "the depression tracks or anticyclones, shift their position, this would effect the variability and extremes of weather at a particular location, and could have a major effect." However it is not known if this happens and in what way [WMO/UNEP, 1990].

Even though the relation between rainfall changes and regional airflow patterns may change in the future, the trends may already have been established in the last decades. This may be what the Loch Lomond results actually show. The alternative explanation may centre round the suggestion that enhanced periods of cyclogenesis is not unknown in the past. The recent period of wetness over Scotland could be a simple short-term secular change and may represent "noise" rather than a true long-term trend. There have been wet periods in the past, e.g. the Little Ice Age, long before the industrial modification of the climate, but few of these periods showed such marked increase in rainfall as shown by the Loch Lomond data post 1970. The trend therefore is real, although its cause is as yet unclear.

5.2 Wider implications of increasing rainfall

In this section, the wider implications of increasing rainfall within the Loch Lomond basin and elsewhere are discussed. Changes have been observed in both climate and hydrologic systems over the last decades and consequently this have an effect on water resources and land use.

5.2.1 Changes in climate and increasing rainfall

The discussed increasing trend of rainfall in the last decades (76.2%, as can be seen in Table 5.1) is in accordance with "the best estimates of changes in precipitation over Britain at equilibrium [which are] an increase of order 5 to 15 percent [...] in annual totals, with most of the increase concentrated in the Winter half of the year" [Rowntree, 1990]. Nevertheless, Rowntree emphasised that this estimate includes "large uncertainties" and the "changes may be dominated by natural variability or by regional variations of atmospheric circulation".

5.2.2 Effects on the hydrologic system, water resources, natural vegetation and land use

There is evidence to show that small changes in precipitation can lead to magnified effects within the catchment. Investigations on impacts of precipitation changes on the hydrological system have demonstrated that even "small fluctuations in precipitation [...] are often amplified by a factor of two or more" on runoff [Karl and Riebsame, 1989], or by evapotranspiration [Wigley and Jones, 1985]. These studies come to the conclusion that for more arid regions "precipitation changes may show a considerably amplified effect in runoff" [Wigley and Jones, 1985].

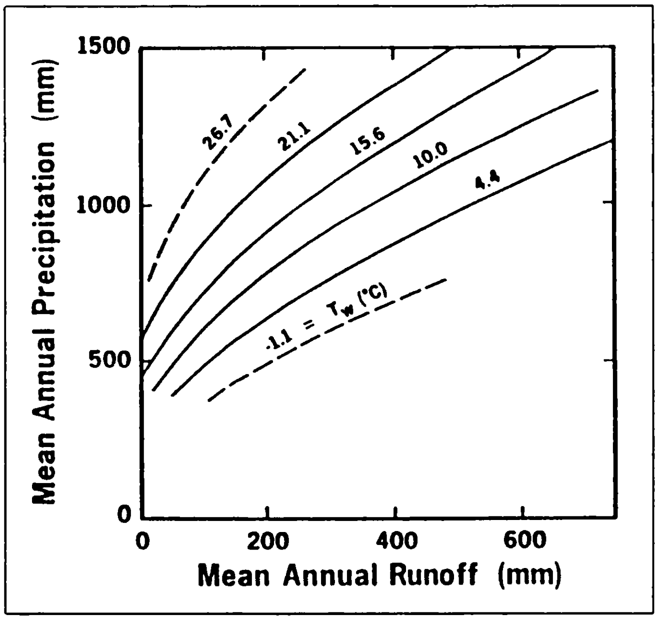

Figure 5.1: The relationship between mean annual precipitation and runoff as a function of the weighted temperature [Karl and Riebsame, 1989].

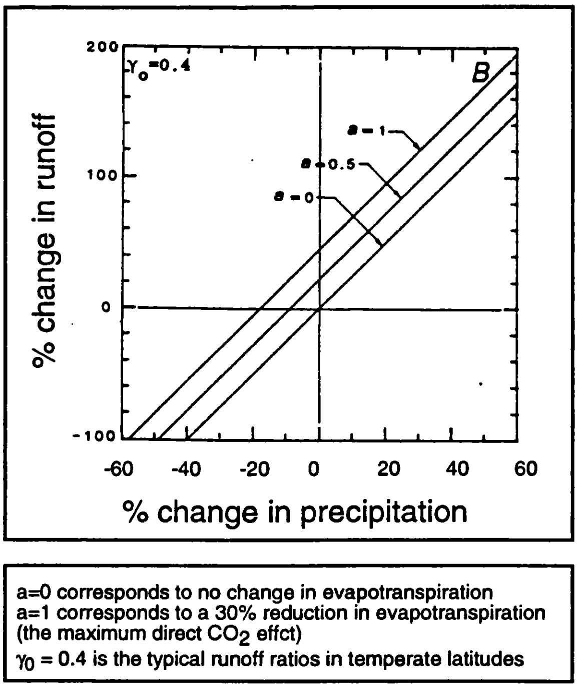

Figure 5.2: Runoff changes due to precipitation changes for different evapotranspiration changes [Wigley and Jones, 1985].

Figures 5.1 and 5.2 show the relationship between precipitation and runoff. Mean annual values were considered in the Langbein curves based on observed differences among basins of the United States (Figure 5.1). Figure 5.2 shows runoff changes due to precipitation changes in terms of percentage, for temperate latitudes, where a typical runoff ratio is around 0.4 (γ_0=0.4)[2]. The sensitivity of this relationship to the direct effects of CO_2 is shown by the parameter a [Wigley and Jones, 1985].

When applied to Britain, the monthly models of river flows indicated an increase in Winter rainfall of 15% in each month, "which determines the increase in annual runoff", whilst "changes in Summer river flows under drier Summer conditions were found to be related to catchment geology and Summer water balance" [Arnell *et al.*, 1990]. The 1990 report of the Institute of Hydrology emphasises that in the UK, "under one climate change scenario, average annual runoff would increase by between 12 and 30% (the greatest increase in the north and west where the effect of the increased evaporation is least) or between 20 and well over 200mm" [Arnell *et al.*, 1990]. These potential changes in rainfall and runoff are extremely important, especially for West Central Scotland where the increases seem to be greater. Such changes were experienced in many catchments after the 1970s [Arnell *et al.*, 1990; Smith and Bennett, 1994] within Scotland and Wales. For example, for the Allan catchment (East Central Scotland) it was found that the pattern of rainfall decline from the 1950s to the 1970s and rise to 1985 correlates with variations in flood magnitude and frequency shown as a fall in flood "frequencies from 1958–71 and an increase from 1971–85 with greatest peaks most sensitive to changes in Autumn and Winter rainfall events" [Rowling, 1989]. This increase in flooding from mid 1970s is registered for several rivers (see Figures 2.14 and 2.16). The mean flow of the river Dee at Woodend between 1970–1989 showed a 40% increase [Smith and Bennett, 1994] but the period before this showed no trend. This increase is also reflected in the Loch Lomond annual average water level (see Figure 2.15).

If winters become generally wetter, it is probable that there is also an increased risk of flooding and recent floods maybe a direct result of changes in the rainfall regime. From

[2]The runoff ratio, γ_0, is defined by

$$R_0 = \gamma_0 P_0$$

where R is runoff (synonymous with streamflow), P is precipitation and subscript zero is used to denote present-day values.

January to March 1990, heavy rainfall was echoed in the recorded flows for the rivers within the Loch Lomond basin and in the loch levels which "were consistently much higher than normal for the time of year" [Pender *et al.*, 1993]. More recently, all of the normal December rainfall fell in just two days and as a result, in 12 December 1994, the Paisley region suffered the worst floods for a century.

Flooding damages structures, has a short-term impact on transport, manufacturing and domestic sector and produces long-term damage to agricultural land. If the frequency of severe weather damage events, such as flooding increases due to climate changes, "this would place financial strain on the insurance industry" [CCIRG, 1990], because of the insurance damage claims mainly from the domestic sector.

In general "wetter winters would benefit water resources [but] increased variability in rainfall, even in a slightly wetter climate, could lead to more droughts in any region of the UK" [CCIRG, 1990]. On the other hand the river, lake and ground water quality could be adversely affected by changes in soil structure caused by climate change and possible changes in land use. Possible increases in water supply during summer, specially on drier areas, depend on reservoir characteristics as small reservoirs may not be able to store the additional winter runoff. If extra winter runoff from North and West needs to be exploited then more or bigger reservoirs would be required [Arnell *et al.*, 1990] and export of water surpluses via pipelines to drier East and South, could be a solution. As yet however, regional water managers in Scotland, although aware of recent trends towards increasing wetness, have no real strategy for copying with it in the future [Smith and Bennett, 1994].

Another problem that must be considered in presence of an increase rainfall scenario, is the urban drainage system in the UK This is usually overloaded in wet weather, and receives overflow from sewage farms direct into water courses at times of overload. Enhanced pollution risks are possible.

Considering that "peak flood magnitudes are highly associated with amount of winter rainfall" [Imeson, 1990] it emerges that erosion and soil degradation will be intensified due to an increase in winter rainfall and will be concentrated in those areas most susceptible to soil degradation. This may be minimal in the non-arable Loch Lomond basin but may be a problem elsewhere.

An increase to vulnerability of land degradation could be a result of "loss of organic matter and a decrease of soil biological diversity" [CCIRG, 1990] which is a potential problem in Southern England and in Eastern parts of the Loch Lomond basin. However, the patterns of land use in the UK in general and in the Loch Lomond basin in particular may change due to climate change because of the implications on soil conditions. Most of the concern is placed on the possible alternate soil shrinkage and swelling given drier, warmer summers and wetter winters. It is possible that general land degradation over the Loch Lomond basin caused by increased rainfall may lead to enhanced winter fluvial erosion caused directly by flooding events. Ultimately this will impact in enhanced sediment delivery along "the loch/shore interface [which] represents one of the most sensitive and pressurised zones within the [Loch Lomond Regional] Park" [Pennington, 1991].

Precipitation changes, like other aspects of climate and weather, have effects on the natural biota, because of microclimate modification. Thus, the natural communities may be less stable, leading to the "extinction of some vulnerable species and the spread of other, aggressive species or weeds may be expected" [Whittaker, 1967]. In general, changes in natural communities and precipitation changes can be expected to reinforce each other [Wigley and Jones, 1985]. A recent report emphasises that for the UK "where rainfall is plentiful [West of Scotland], an increase in CO_2 concentration accompanied by a lengthening of the growing season is likely to increase the productivity of vegetation" [CCIRG, 1990]. The same report suggests that in the UK as a whole, there will be significant migration of species northwards, of which the first movements will be of invertebrates, birds and 'weedy' plant species. Some native species and communities will retreat and may be lost to the UK. On the other hand, "invertebrate and avifauna may be enriched in much of the UK" [CCIRG, 1990].

In the Loch Lomond catchment the present pattern of vegetation "is the result of an evolution over millennia, during which the activities of man and changing environment conditions have played a continuous role" [Dickinson, 1994]. Considering that "a surplus rather than a deficit of water is the main biological problem associated with Scotland's characteristically humid climate" [Tivy, 1983], the increase in rainfall in Central West Scotland will certainly intensify biological problems in the Winter half-year season.

Under wetter conditions and possible modification on soil structure, moisture, degradation and erosion together with variations on the loch water level, the actual vegetation cover is likely to change and this presents interesting challenges for conservation strategies.

The impacts of climate change on the future patterns of land use is unknown, but it is known that whether land use changes "by socio-economic decision or climate change could influence the natural biota as much as climate change itself" [CCIRG, 1990]. Temperature is the strongest factor in the UK influencing crop production, but rainfall changes have also important influences. Thus, increases in winter rainfall promotes an excessive soil moisture which implies less arable soil, "leaches nutrients, inhibits microbial activity and limits plant growth because of water-logged root systems" [CCIRG, 1990]. Otherwise deficiencies in soil moisture in Summer can restrict canopy expansion and productivity. These estimated effects are extremely important in terms of land use because, coupled with changes in other environmental aspects and UK economic policies, they may have major implications for agricultural and forestry.

Over the Loch Lomond basin these aspects must be taken in account because of spatial differences in rainfall distribution, which will bring different responses in terms of adjustments to soil structure and degradation, natural communities and land use. Agriculture, forestry, outdoor recreation, tourism and conservation are some of the activities recently identified in the Loch Lomond catchment [Dickinson, 1994]. The spatial patterns of these land uses and other activities like "field sports, water catchment and utilisation, hydro-electric power generation, mineral extraction, settlement and [...] some industry" [Dickinson, 1994] are sensitive to climate changes and policy strategies. A wetter climate itself could be an important factor in land use changes inducing more extensive grass land and may condition outdoor recreation activities. Nevertheless, it also depends on other major climatic changes such as temperature and on future land use policies.

Tourism and outdoor recreation are growing rapidly in the Loch Lomond area and this highlights conflicts between development and conservation strategy. The impacts of climate changes on recreation and tourism are mainly considered advantageous because of the expected higher temperatures, except for some winter sports in upland Scotland. However, increases in rainfall have the opposite effect as tourists prefer dry weather during their leisure time. One of the major concerns of changes in climate and recreation impacts is to determine "the competitive land use balance between outdoor recreation and agriculture" [CCIRG, 1990] in upland Britain if climatic changes occur.

5.3 The methodology used

A general discussion of the methodology used in the study is presented in this section. The methods used in the data selection, preparation and analysis are discussed in terms of efficiency in the presence of the results.

5.3.1 Selection and group of rainfall stations

As was presented in Chapter 3, the objective in selecting and grouping rainfall stations, from the existent network of stations, was to obtain representative rainfall trends and variability for all parts of the catchment basin. In the view of the objectives, the simple empirical method of selecting stations by analysing location in the basin and period of records was satisfied. The same is true of the grouping of nearby stations in order to obtain longer data sets. A station by station study is also more sensitive to local variation at the scale of a catchment basin.

5.3.2 Preparation of data

The data preparation presented in the Chapter 3, was an important step for the obtained results. Simple but efficient techniques were used in estimating missing data, checking for data consistency and adjusting values and these contributed to a much better quality of data used in the analysis of trends in pattern and variability of rainfall in the Loch Lomond basin.

Estimation of data

Data estimation carries risks but the results of the parallel estimation are completely satisfied and could be used with confidence, due to the averaging procedure used.

However the use of single estimated values, whether for monthly or annual amounts, demands care. In the present work, on temporal analysis (which frequently uses averaged values) the estimated values were very useful and gave continuity to the rainfall values. Furthermore, considering that no extrapolation of data was used, the series obtained could thus be used with a high degree of confidence.

Check for data homogeneity

The assessment of homogeneity of the data series that resulted from the combination of real and estimated values and from the grouping of stations revealed that the methods used for selecting and grouping stations and of estimating data were correctly applied. Hence, the confidence in using the resultant data series was reinforced. Only in one case (station I) an inconsistency was identified because of the use of two different stations. This was successfully overcome by adjusting the observed values via doubled mass analysis. This proved to a be a very useful technique in assessing the series homogeneity and in adjusting observed records.

5.3.3 Data analysis

The methods used in the data series analysis presented in Chapter 3 were chosen considering the nature of the problem presented, the scale of the study area and the possible use of the results.

Simple statistical methods were used throughout in order to characterise the temporal and spatial rainfall behaviour in the study area and the end results showed the methodology used to be satisfactory for the identification of changes in variability and of trends and fluctuations.

Although a time-series analysis was done, predictions were not inferred because prediction is subject to several pitfalls and was outwith the scope of this work. Furthermore, while climatic prediction on a global scale is quite advanced, on a regional and local scale it is still under development and there are not yet satisfactory regional and local climatic prediction models available. This could constitute a very good topic for future research, using the Loch Lomond basin as a basis for local climatic prediction models.

Time-series analysis

The use of the hydrological year beginning in October, instead of the calendar year, for annual amounts and the half-year and the half-year beginning in October and April, for seasonal amounts was a good option considering the possible usage of the present results for hydrologists. Several studies of rainfall in the UK have made use of the calendar year (by convenience) which is not the natural period of the annual rainfall cycle. Nevertheless, the extra work of calculating the rainfall amounts for the hydrological year, as well as the Winter and Summer half-years, is advisable because of "the advantage of bringing the whole of the Winter into one group and the whole of the Summer into the other, whereas in the calendar year the Winter is divided into two halves, one half being in one year and the other in the following year" and "any excess or deficiency of rainfall affecting the whole Winter" is thus studied separately [Mill, 1913].

The interannual rainfall variability measured by the percentage of the deviation of the actual values from the general mean and plotted graphically facilitated the analysis in terms of the intensity of deviations and the significance of the changes in the variability. It also helped in defining dry and wet periods. Nevertheless, in a more detailed study of changes in the interannual variability "the difference in absolute sense between two consecutive" [Schuurmans, 1990] years, Winter or Summer rainfall must be also analysed, as well as "the frequency and intensity of extreme deviations [which] is one of the most essential parameters" [Flohn, 1984].

The main trends and fluctuations in the long and short term were easily obtained with the methodology adopted. While the 5-years moving average allowed the identification of short term fluctuations, the polynomial curve fitting gave large amplitude fluctuations. The last technique of curve smoothing is preferable than regression lines since not only is a visualisation of the general trends possible, but also the medium and short-term oscillations are identified by the curves. Furthermore, as the use of the regression line for climatic elements has been criticised by some authors, greater reliance for short and medium-term trends should be placed on the polynomial fits and 5-years moving averages rather than the regression lines.

Spatial scale analysis

In spite of criticism that 30 years average rainfall values obscure the natural variability and occurrence extremes, [Lamb, 1982; Glasspoole, 1979] it is a useful reference for identification of major spatial changes in rainfall and for evaluation of the magnitude of spatial variability. The analysis of areal distribution of 35 or 30 years average annual rainfall by the three isohyetal maps conveyed both the general rainfall distribution in the area and the major changes in rainfall quantities and distribution. Although changes occur in the period of rainfall average and "averages for 35 or more being much more uniform"

[Glasspoole, 1979], it is possible to draw some conclusions related with changes in spatial patterns. Nevertheless, it should be remembered that the maps are a result of subjective interpretation of the data and that the recent maps are more detailed due to the greater number of records available. The maps were drawn empirically, due to the altitude of the area, and so they must be used only with caution and in a synoptic rather than specific sense. The altitudinal influence, especially in the North, should not be underestimated.

Chapter 6

Conclusions

The main findings of this research are summarised below, followed by an evaluation of wider implications. Finally the work is criticised and future research is pointed out.

6.1 Summary of aims, results and discussion

The conclusions of the analysis presented in this dissertation tend to confirm the prior hypothesis of an increase in rainfall over West Central Scotland, concentrated in the Winter season. This rainfall change is an important cause of some other changes taking part in the area. Thus, the aims of this work, establishing changes in the rainfall regime in West Central Scotland have been achieved; seasonal changes were demonstrated; and wider effects and potential effects of these changes on the area were pointed out.

Although some rainfall data series used are of short length, this was compensated by others with sufficiently long term records to allow the work to establish the magnitude and amplitude of rainfall variations over the present century. The time series of the rainfall stations used gives a coverage of the whole basin which made it possible to characterise rainfall changes in the time and space for the Loch Lomond basin.

Rainy, normal and dry years, Winters and Summers were defined on the basis of the standard deviation and revealed the variability with runs of rainy, normal and dry years. The rainfall interannual variability was identified by the analysis of the annual and seasonal percentage of deviation from the mean. Both of these analyses reveal the amount of rainy years since 1984/85 within an increasing trend from 1968/69. A real anomaly was detected in terms of rainfall interannual variability; this was the greatest interannual variability ever recorded and occurred between 1984 (a very dry year) and 1985 (a very rainy year) with fluctuations between 79% to 111% of annual rainfall amounts for the studied stations within the basin.

Time-series smoothing using a 5 years moving average and polynomial curve fitting produced very satisfactory results in terms of the annual and seasonal (half-years) characteristics of the rainfall over time in the study area. The advantage of this analysis over the regression analysis is that of yielding more realistic temporal results, considering the rainfall variations in terms of fluctuations and trends. A trend revealed by the analysis is the marked increase in annual and Winter rainfall over the last 22 years, similar in direction for the whole basin and higher in magnitude in the Northwest. For the basin as a whole, the mean increase is 76% in that period, with around 80% to 99% in the Northwest and between 56% and 63% in the Southern part of the basin. A discussion point is whether this real increase could be considered as a real change in long-term trends or only a main fluctuation before a return to prior conditions. The results from G.C.M.s suggest the beginning of a long-term trend but these are unproven as yet. Nevertheless, this result is important in terms of potential effects in the area which must be taken into account for management purposes.

Contrary to the indications from G.C.M.s that Britain shows a decreasing trend in Summer rainfall, in the Loch Lomond drainage basin this is not a general feature: from the end of the 70s there is a tendency for slightly increasing rainfall Summer half-year amounts. If this is a real trend, the problems originated by water surplus will be aggravated over the whole year and not only during Winter months.

In spite of several fluctuations found during the period of records analysed, the increasing trend remains the most interesting rainfall feature because of its relationship with "recent increases in the intensity of the Winter atmospheric circulation over the extropical [...] Atlantic" [IPCC, 1992]. This increase is hypothetically linked with the global warming caused by the enhanced 'greenhouse effect'. This hypothetical relationship requires further investigation as there is no firm evidence of it as yet.

The spatial analysis of average annual rainfall revealed an intensification in the spatial variability within the Loch Lomond basin, i.e., the very wet areas of the Northwest are becoming wetter and the areas of the Southeast maintaining its relative dryness, and this is very marked in the middle of the River Endrick basin. The local features of the

Loch Lomond basin associated with regional and global changes in climatic elements and in atmospheric circulations explain the rainfall spatial variability and rainfall temporal changes over the study area. Nevertheless, research on atmospheric circulation changes which "are likely to be an important component of future regional climatic change" [IPCC, 1992] is not as well advanced as is desirable.

6.2 Wider implications of this research

Although it was not possible to attribute the results of the present research to greenhouse forcing or other factors, the results could be an indication of long term climatic change in West Central Scotland and so contribute to the evaluation of potential effects on the area.

Several preoccupations about changes and potential changes in Loch Lomond and West Scotland will be aggravated if the trend to increasing precipitation proves to be continuous. These preoccupations are mainly associated with the potential effects on the hydrologic system and flooding, changes to the loch levels and its relationship with shore erosion, local ecosystem effects and effects on the land use in the catchment.

6.3 Critique and future research

The present research began because of the great interest and topicality of this issue. Detecting climatic changes by observational records at a local scale of a basin is required in order to indicate whether the local climate is affected by global changes and otherwise as an indication for studies at a global scale. During the research, the problem, aims and research approach and the study area were clearly defined. Although there is good coverage of the area in terms of rainfall stations, many of them have very short records; there are several gaps in the records which needed the use of estimated values both for monthly amounts and 30 years annual averages. There are always risks in using estimates, but these are justified to allow analyses to be made.

The temporal and spatial analysis was mostly satisfactory but the evaluation of general trends in terms of significance is required by using either the Mann-Kendall or Spearman rank statistic because trends in a climatic time series are seldom linear [Olaniran, 1991].

The increase in rainfall over West Central Scotland as a result of the present trend of an intensification of westerly atmospheric circulation needs further examination, mainly because "the present synoptic record back to the mid-19th century is not long enough to determine whether or not the fluctuations in the frequency of the westerly type are simply random oscillations in a general trend or are themselves part of a more-or-less regular cyclic pattern" [Kington, 1975].

On the other hand, to better understand regional rainfall variations in relation to global warming and the enhanced 'greenhouse effect' it appears that studies of rainfall totals (like this one) must be done "in conjunction with [studies of] rainfall of higher intensity at daily and smaller time intervals" [Yu and Neil, 1991]. In the case of West Central Scotland, it is import to continue investigation in this subject due to recent flooding problems (e.g., January 1990 to March 1990 and December 1994) and due to increasing river flows over the last 20 years.

Further research is also necessary to establish the nature of impacts of rainfall changes on the natural environment and human activities, not only in West Central Scotland but in other areas.

Bibliography

[Anyadike, 1993] R.N.C. Anyadike. Seasonal and annual rainfall variations over Nigeria. *International Journal of Climatology*, 13:567–580, 1993.

[Arnell *et al.*, 1990] N.W. Arnell, R.P.C. Brown, and N.S. Reynard. Impact of climatic variability and change on river flow regimes in the UK. Technical Report 107, Institute of Hydrology, Oxforshire, UK, December 1990.

[Atkinson and Smithson, 1976] B.W. Atkinson and P.A. Smithson. Precipitation. In T.J. Chandler and Gregory S., editors, *The Climate of the British Isles*, chapter 6. Longman, London and New York, 1976.

[Barry and Chorley, 1968] R.G. Barry and R.J. Chorley. *Atmosphere, Weather & Climate.* Methuen & Co Ltd, London, third edition (1976) edition, 1968.

[Bradley *et al.*, 1987] R.S. Bradley, H.F. Diaz, J.K. Eischeid, P.D. Jones, P.M. Kelly, and C.M. Goodess. Precipitation fluctuations over Northern Hemisphere land areas since the mid-19th century. *Science*, 237:171–175, 1987.

[Carniel *et al.*, 1990] R. Carniel, M. Ceschia, and S. Micheletti. Short analysis of rainfall trends in Friuli-Venezia Giulia from 1951 to 1986. *Il Nuovo Cimento*, 13 C(5):885–888, 1990.

[CCIRG, 1990] CCIRG. The potential effects of climate change in the United Kingdom. Technical Report first, Climate Change Impact Review Group, U.K. HMSO, January 1990. Prepared at the request of the Department of the Environment.

[Curran and Poodle, 1991] J.C. Curran and T. Poodle. Hydrological characteristics of Loch Lomond - are they changing? In Dickinson et al. [1991].

[Dickinson *et al.*, 1991] G. Dickinson, G. Jones, and G. Pender Crest, editors. *Loch Lomond 1991, Strathclyde University, 26 April 1991*, University of Glasgow and Strathclyde University, 1991.

[Dickinson, 1994] G. Dickinson. Vegetation and land use in the Loch Lomond catchment. *Hydrobiologia*, 00:1–9, 1994.

[DoE, 1991] DoE. Global climate change. Technical report, The Department of the Environment and the Meteorological Office, 1991. U.K. HMSO.

[DoE, 1992] DoE. Climate change, our national programme for CO_2 emissions. Technical report, The Department of the Environment, December 1992. A Discussion Document.

[Duplessy *et al.*, 1990] J.C. Duplessy, A. Pons, and R. Fantechi, editors. *Climate and Global Change — Environment and Quality of Life (4 to 12 April 1990).* Comission of the E.C., 1990.

[Flohn, 1984] H. Flohn. Climate variability and its time changes in european countries, based on instrumental observations rainfall and water budget. In H. Flohn and Fantechi R., editors, *The Climate of Europe: Past, Present and Future Natural and Man-induced Climatic Changes: An European Perspective.* D. Reidel Publishing Company, Dordrecht, Boston, Lancaster, 1984.

[Glasspoole, 1979] J. Glasspoole. Some comments on rainfall averages — past and present. *Weather*, 34(11):441–442, 1979.

[Goodess *et al.*, 1992] C.M. Goodess, J.P. Palutikof, and T.D. Davies. *The Nature and Causes of Climate Change Assessing the Long-term Future.* Belhaven Press-London, Lewis Publishers, London, 1992.

[Gregory *et al.*, 1991] J.M Gregory, P.D. Jones, and T.M.L. Wigley. Precipitation in Britain: an analysis of area-average data updated to 1989. *International Journal of Climatology*, 11(3):331–345, 1991.

[Gregory, 1968] S. Gregory. *Statistical Methods and the Geographer.* Longman Group Limited, London, second edition, 1968.

[Gregory, 1975] S. Gregory. On the delimitation of rainfall patterns of recent climatic fluctuations. *Weather*, 30(9):276–287, 1975.

[Gregory, 1979] S. Gregory. The definition of wet and dry periods for discrete regional units. *Weather*, 34(9):363–369, 1979.

[Hammond and McCullagh, 1978] R. Hammond and P. McCullagh. *Quantitative Techniques in Geography: an Introduction.* Oxford University Press, Oxford, second edition, 1978.

[HCCPR, 1992] HCCPR. The Hadley Centre Transient Climate Change Experiment. Technical report, The Hadley Centre for Climate Prediction and Research, August 1992.

[Hjelmfelt, 1975] A.T. Hjelmfelt. *Hydrology for Engineers and Planners.* 1975.

[Imeson, 1990] A.C. Imeson. Climate, global change and land degradation. In Duplessy et al. [1990].

[IPCC, 1992] IPCC. Climate change 1992. The supplementary report to the IPCC scientific assessment. Technical report, WMO and UNEP, 1992. Edited by J.T. Houghton, B.A. Callander and S.K. Varney.

[Jones *et al.*, 1990] G. Jones, A. Robertson, J. Forbes, and G. Hollier. *Dictionary of Environmental Science.* Harper Collins Publishers, Glasgow, 1990.

[Jones, 1991] G.E. Jones. Local climate and climate change. In Dickinson et al. [1991].

[Karl and Riebsame, 1989] T.R. Karl and W.E. Riebsame. The impact of decadal fluctuations in mean precipitation and temperature on runoff: a sensitivity study over the United States. *Climatic Change*, 15:423–447, 1989.

[Katz and Brown, 1992] R.W. Katz and B.G. Brown. Extreme events in a changing climate: Variability is more important than averages. *Climate Change*, 1992.

[Kington, 1975] S.A. Kington. A comparison of British Isles weather type frequencies in the climatic record from 1781 to 1971. *Weather*, 30(1):21–24, January 1975.

[Kowal and Kassam, 1975] J.M. Kowal and A.H. Kassam. Rainfall in the Sudan savanna region of Nigeria. *Weather*, 30(9):276–287, September 1975.

[Lamb, 1964] H.H. Lamb. *The English Climate.* The English Universities Press Ltd., London, second edition, 1964.

[Lamb, 1982] H.H. Lamb. *Climate, history and the Modern World.* Methuen, London and New York, 1982.

[Linacre, 1992] E. Linacre. *Climate Data and Resources a reference and guide.* Routledge, London and New York, 1992.

[Mayes, 1991] J. Mayes. Regional airflow patterns in the British Isles. *International Journal of Climatology*, 11:473–491, 1991.

[MetOffice, 1977] Map of average annual rainfall (mm), 1941-70, 1977. Her Majesty's Stationery Office, Meteorological Office, London.

[MetOffice, 1979] Map of average rainfall (mm), period 1941-70, Summer half-year (April-September), 1979. Meteorological Office.

[MetOffice, 1989] MetOffice. The climate of Scotland: Some facts and figures. Technical report, Her Majesty's Stationery Office, Meteorological Office, London, 1989.

[MetOffice, 1992] MetOffice. Rainmaster extract from the Meteorological Office computer index of rainfall stations data, January 1992. Meteorogical Office Headquarters, London Rd, Bracknell, Berks, RG12 2SZ, UK.

[MetOffice, 1993] MetOffice. Rainmaster extract from the Meteorological Office computer index of rainfall stations data, February 1993. Meteorogical Office Headquarters, London Rd, Bracknell, Berks, RG12 2SZ, UK.

[Mill, 1913] H.R. Mill. On the distribution of rain in space and time over the Bristish Isles during the year 1912. *British Rainfall*, 10, 1913.

[Mitchell, 1990] J.F.B. Mitchell. The physics and dynamics of the climate system: Simulation of climate. In Duplessy et al. [1990].

[Nicholls and Lavery, 1992] N. Nicholls and B. Lavery. Australian rainfall trends during the twentieth century. *International Journal of Climatology*, 12:153–163, 1992.

[Olaniran, 1991] O.J. Olaniran. Evidence of climatic change in Nigeria. *Climatic Change*, 19:319–340, 1991.

[Oliver, 1981] John E. Oliver. *Climatology: Selected Applications.* V.H. Winston & Sons and Edward Arnold, USA; London, 1981.

[Peixoto, 1987] J.P. Peixoto. *O Homem, O Clima e o Ambiente II. As Variações do Clima e o Ambiente.* Secretaria de Estado do Ambiente e dos Recursos Naturais, Lisboa, 1987.

[Pender *et al.*, 1993] G. Pender, G. Dickinson, and J.G. Herbertson. Flooding and shore damage at Loch Lomond, January to March 1990. *Weather*, 48(1):8–15, 1993.

[Pennington, 1991] N.C. Pennington. Shore management in the Loch Lomond Regional Park. In Dickinson et al. [1991].

[Reynolds, 1985] G. Reynolds. Extreme rainfall events in Scotland. In S.J. Harrison, editor, *Climatic Hazards in Scotland, Proceedings of the Joint Royal Scottish Geographical Society and Royal Meteorological Society Symposium, University of Stirling, June 1984*, Norwich, UK, 1985. Geo Books.

[Rind *et al.*, 1989] D. Rind, R. Goldberg, and R. Ruedy. Change in climate variability in the 21st century. *Climatic Change*, 14:5–37, 1989.

[Rowling, 1989] P. Rowling. Rainfall variation and some implications for flooding in the Allan catchment, central Scotland. *Weather*, 44:146–154, 1989.

[Rowntree, 1990] P.R. Rowntree. Estimates of future climatic change over Britain, part 2: Results. *Weather*, 45(3):79–89, 1990.

[Rupa Kumar *et al.*, 1992] K.R. Rupa Kumar, G.B. Pant, Parthasarathy, and N.A. Sontakke. Spatial and subseasonal patterns of the long-term trends of indian Summer monsoon rainfall. *International Journal of Climatology*, 12:257–268, 1992.

[Schuurmans, 1990] C.J.E. Schuurmans. Climatic evolution during the last century. In Duplessy et al. [1990].

[Sivakumar, 1992] M.V.K. Sivakumar. Climate change and implications for agriculture in Niger. *Climatic Change*, 20:297–312, 1992.

[Smith and Bennett, 1994] K. Smith and A.M. Bennett. Recently increased river discharge in Scotland: Effects on flow hydrology and some implications for water management. *Applied Geography*, 14(2), April 1994.

[Stringer, 1972] E.T. Stringer. *Techniques of Climatology.* W.H. Freeman and Company, San Francisco, 1972.

[Tabony, 1981] R.C. Tabony. A principal component and spectral analysis of european rainfall. *Journal of Climatology*, 1(3):283–294, 1981.

[Tivy, 1983] Joy Tivy. The bio-climate. In C.M. Clapperton, editor, *Scotland, a New Study*, chapter 3. David & Charles, Newton Abbot, London North Promfret, 1983.

[Vines, 1985] R.G. Vines. European rainfall patterns. *Journal of Climatology*, 5(6):607–616, 1985.

[Whittaker, 1967] R.H. Whittaker. Ecological implications of weather modifications. In R. Shaw, editor, *ground level Climatology, Symposium of Association for Advancement of Science (December 1965, Washington, D.C.)*, 1967.

[Whittow, 1984] J Whittow. *Dictionary of Physical Geography.* Penguin Books, London, 1984.

[Wigley and Jones, 1985] T.M.L. Wigley and P.D. Jones. Influences of precipitation changes and direct CO_2 effects on streamflow. *Nature*, 314:149–152, March 1985.

[Wigley and Jones, 1987] T.M.L. Wigley and P.D. Jones. England and Wales precipitation: a discussion of recent changes in variability and an update to 1985. *Journal of Climatology*, 7:231–246, 1987.

[Wigley *et al.*, 1984] T.M.L. Wigley, J.M. Lough, and P.D. Jones. Spatial patterns of precipitation in England and Wales and a revised, homogeneous England and Wales precipitation series. *Journal of Climatology*, 4:1–25, 1984.

[WMO/UNEP, 1990] WMO/UNEP. Scientific assessment of climate change the policymakers' summary of the report of working group I to the IPCC. Technical report, World Meteorological Organization, United Nations Environmental Programme, July 1990.

[Wright, 1976] P.B. Wright. Recent climatic changes. In T.J. Chandler and S. Gregory, editors, *The Climate of the British Isles*, chapter 10. Longman, London and New York, 1976.

[Yevjevich, 1993] V. Yevjevich. Water resources and statistics: Past, present and future. In V. Barnett and K.F. Turkman, editors, *Statistics for the Environment (Proceedings of the SPRUCE Conference held in the Calouste Gulbenkian Centre, Lisbon, Portugal, 7-10 April 1992)*, Chichester, New York, Brisbane, Toronto, Singapure, 1993. John Wiley & Sons Ltd.

[Yu and Neil, 1991] B. Yu and D.T. Neil. Global warming and regional rainfall: The difference between averages and high intensity rainfalls. *International Journal of Climatology*, 11(6):653–661, 1991.

Appendix A

Monthly rainfall records and estimated values

In this appendix the monthly rainfall records for all selected rainfall stations are presented and the total annual calculated for the hydrometeorological year (Oct–Sep). The estimated values are also presented in italic plus summary statistical values calculated.

The stations XII, XIII and XIV are located outside Loch Lomond basin and are used as control stations.

Station I (Allt Nan Caorrunn, Dubh Eas):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1947/48				293.1	358.7	440.2	228.4	94.7	189.7	240.5	322.8	458.2	
1948/49	527.6	252.7	389.1	556.5	440.5	161.8	443.0	153.2	81.3	139.2	248.4	179.1	3196.9
1949/50	416.1	336.1	677.7	278.4	314.2	190.8	243.3	80.3	188.0	330.7	311.9	569.0	3522.7
1950/51	448.8	228.1	128.5	313.2	152.7	149.1	220.2	62.5	102.9	232.2	248.9	267.7	2286.3
1951/52	143.8	375.7	523.3	215.9	127.0	262.9	144.3	91.7	192.0	185.4	256.0	221.8	2451.8
1952/53	344.4	104.7	294.4	306.6	264.4	129.0	175.5	141.7	35.1	313.2	262.1	451.6	2526.1
1953/54	291.9	609.9	344.2	284.5	154.9	212.9	160.5	147.8	210.6	185.7	253.8	424.5	2936.2
1954/55	533.2	471.4	650.0	160.8	93.5	41.7	200.9	154.7	154.4	25.9	79.0	294.4	2559.3
1955/56	330.5	156.7	551.5	200.7	133.1	145.3	129.8	225.8	200.4	217.7	207.8	265.9	2474.5
1956/57	287.0	233.7	451.4	437.4	192.3	321.1	125.7	101.6	136.1	222.3	272.3	189.0	2657.8
1957/58	450.6	137.2	413.5	339.4	140.2	83.1	153.9	240.5	97.3	153.7	271.0	276.9	2467.5
1958/59	329.5	88.4	305.8	79.0	176.0	295.2	221.5	63.8	207.8	277.1	190.8	72.1	2064.5
1959/60	366.5	332.2	485.2	210.3	246.6	109.2	334.8	181.4	164.9	250.2	145.8	149.6	2663.9
1960/61	161.8	338.1	413.0	372.6	409.4	315.5	210.3	151.1	197.4	245.4	421.9	379.2	3235.7
1961/62	436.4	294.1	225.3	566.4	403.6	92.5	104.1	154.2	258.3	150.4	441.2	341.9	3103.9
1962/63	246.4	123.7	343.2	37.1	82.6	425.5	259.1	261.1	161.5	150.9	203.2	273.1	2297.6
1963/64	415.5	299.0	183.4	218.7	138.4	92.2	252.7	288.3	160.0	292.1	249.7	337.3	2619.6
1964/65	225.8	340.6	414.3	394.2	76.7	210.8	228.6	203.2	339.6	148.6	294.6	279.9	2825.1
1965/66	376.4	190.2	455.4	197.4	296.9	389.1	167.4	226.8	246.1	97.0	117.1	288.8	2728.2
1966/67	158.2	319.0	506.2	264.7	397.3	649.5	181.6	245.9	196.3	288.8	171.2	320.3	3310.2
1967/68	450.9	192.0	242.6	283.7	124.2	284.7	83.1	130.6	112.8	129.8	110.2	201.7	2099.7
1968/69	445.5	165.4	126.2	224.5	83.6	40.6	87.9	108.2	196.3	173.7	140.2	225.3	2017.4
1969/70	338.1	284.0	201.7	207.5	208.3	143.3	210.8	124.2	137.9	335.5	144.5	343.9	2679.7
1970/71	448.1	301.0	185.9	285.0	240.0	165.1	85.0	127.6	121.9	90.0	214.2	97.1	2360.9
1971/72	465.2	237.5	345.7	290.8	142.5	127.0	220.8	232.3	204.0	154.2	126.8	44.8	2591.6
1972/73	190.5	320.0	330.0	260.0	275.0	181.2	125.0	133.9	227.0	82.6	212.0	153.0	2490.2
1973/74	88.0	337.8	322.0	670.3	266.5	106.0	11.4	151.9	101.1	210.4	230.0	238.2	2733.6
1974/75	89.5	391.0	582.7	575.0	137.2	94.6	130.0	22.7	136.5	183.5	120.5	367.4	2830.6
1975/76	215.0	285.0	213.0	473.6	207.8	257.3	145.0	243.4	161.1	124.8	43.4	134.3	2503.7
1976/77	310.0	360.0	158.7	250.4	174.2	310.6	256.7	82.9	82.0	137.9	131.2	435.7	2690.3
1977/78	304.9	351.5	185.0	250.0	170.0	322.0	37.5	58.2	122.4	107.6	117.8	465.0	2491.9
1978/79	265.2	502.6	187.0	206.0	68.1	360.0	134.2	100.3	181.1	170.0	218.0	312.3	2704.8
1979/80	312.0	485.0	314.6	204.6	155.3	178.4	16.4	25.3	215.7	221.0	163.4	473.0	2764.7
1980/81	274.8	358.6	514.0	320.0	208.3	315.0	28.4	178.2	162.5	168.4	88.0	458.4	3074.6
1981/82	330.0	484.0	113.0	321.8	260.3	258.0	76.0	159.2	78.4	60.0	306.9	504.8	2952.4
1982/83	327.6	412.8	370.0	559.7	90.0	357.8	82.0	184.0	124.8	90.0	67.0	307.5	2973.2
1983/84	663.6	119.5	469.0	450.0	230.0	90.3	140.5	12.2	138.8	76.0	108.5	260.8	2759.2
1984/85	402.0	433.0	343.4	104.6	132.8	146.2	*238.8*	100.0	107.0	*459.3*	472.8	340.5	*3280.4*
1985/86	184.3	165.9	*559.8*	322.4	4.2	400.4	103.4	457.6	93.9	158.6	221.8	105.7	*2778.0*
1986/87	400.0	600.0	564.0	120.0	187.8	261.3	95.9	111.0	117.7	154.6	170.0	380.4	3162.7
1987/88	269.0	227.1	375.2	362.2	317.0	334.8	86.5	100.1	34.8	410.5	293.6	320.8	3131.6
1988/89	334.6	137.9	400.0	444.1	578.2	365.0	80.6	70.0	128.1	70.0	437.0	212.0	3257.5
1989/90	410.0	111.7	115.7	482.0	528.0	665.7	164.5	65.8	190.3	132.2	210.7	277.5	3354.1
1990/91	460.7	123.1	410.0	363.7	120.1	266.2	370.7	40.2	190.0	159.8	145.9	291.4	2941.8
1991/92	351.2	440.0	310.0	330.0	389.0	475.0	217.1	175.7	52.2	176.4	503.5	339.5	3759.6
1992/93	120.5	372.9	247.3										
μ	332.0	298.5	354.3	313.1	219.9	249.4	164.8	143.7	154.2	186.3	221.5	296.3	2779.8
SD	124.7	133.1	149.2	139.2	126.7	144.7	90.3	83.4	61.0	91.1	109.5	120.4	390.2
CV	37.6	44.6	42.1	44.5	57.6	58.0	54.8	58.0	39.6	48.9	49.4	40.7	14.0
skew	0.0	0.3	0.2	0.5	1.0	0.9	0.8	1.2	0.3	0.9	0.8	0.0	0.3
min	88.0	88.4	113.0	37.1	4.2	40.6	11.4	12.2	34.8	25.9	43.4	44.8	2017.4
Q1	265.2	190.2	225.3	215.9	133.1	143.3	95.9	91.7	112.8	132.2	140.2	221.8	2500.8
Me	330.5	301.0	344.2	290.8	187.8	257.3	153.9	133.9	160.0	168.4	212.0	291.4	2730.9
Q2	416.1	372.9	455.4	372.6	275.0	322.0	220.8	181.4	196.3	232.2	271.0	367.4	3081.9
max	663.6	609.9	677.7	670.3	578.2	665.7	443.0	457.6	339.6	459.3	503.5	569.0	3759.6

Station II (Lairig, Arnan):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1947/48				295.4	325.4	410.0	231.4	94.0	212.4	244.1	333.8	463.8	
1948/49	510.1	226.8	445.8	528.3	465.3	172.2	458.2	149.1	85.1	157.2	250.2	137.4	3585.9
1949/50	412.5	369.1	629.7	303.5	316.5	212.9	233.4	78.0	182.4	353.3	344.9	337.1	3773.3
1950/51	438.4	225.1	119.6	351.5	210.6	170.7	215.4	65.3	102.6	258.8	211.1	242.1	2611.2
1951/52	130.6	400.1	509.8	208.5	127.0	267.2	152.9	88.9	213.6	216.2	279.7	221.0	2815.4
1952/53	349.8	105.4	305.8	336.1	260.1	110.0	174.0	168.2	36.3	312.9	250.7	454.7	2864.0
1953/54	301.3	592.6	352.3	307.4	192.3	205.7	159.8	153.9	225.6	185.7	250.2	424.5	3351.2
1954/55	521.7	504.5	678.2	161.6	135.6	43.4	206.5	163.6	172.5	30.0	72.1	285.0	2974.7
1955/56	304.3	176.3	564.2	213.4	150.9	162.1	128.8	225.6	207.5	243.8	216.4	294.7	2887.8
1956/57	282.0	271.8	577.6	484.4	258.3	339.1	125.0	104.4	140.0	223.0	305.1	234.5	3345.1
1957/58	442.2	156.2	436.1	372.1	159.3	90.2	169.9	239.8	99.3	168.9	264.9	262.9	2861.9

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1958/59	349.0	92.0	318.5	95.0	171.5	276.1	244.4	81.3	217.2	297.2	228.1	74.2	2444.3
1959/60	355.1	347.7	439.4	205.0	272.6	109.5	345.5	169.9	158.5	252.2	135.9	152.9	2944.2
1960/61	155.2	334.8	386.1	366.5	380.5	389.9	219.2	185.9	208.8	249.9	404.1	365.0	3645.9
1961/62	427.7	248.2	260.4	615.4	400.6	86.6	100.8	155.7	265.9	144.5	448.3	337.6	3491.7
1962/63	193.3	152.1	355.6	12.4	88.9	444.0	228.3	258.1	140.0	139.7	197.4	255.3	2465.1
1963/64	383.0	287.8	155.2	212.1	135.4	69.3	244.1	273.8	169.4	289.6	252.7	293.9	2766.3
1964/65	199.9	355.3	395.5	328.9	79.0	205.5	258.6	205.2	317.5	153.7	280.2	256.5	3035.8
1965/66	315.7	148.1	433.8	204.2	287.0	341.4	154.2	216.2	210.1	92.2	131.6	305.8	2840.3
1966/67	169.9	304.5	505.7	308.1	415.0	625.9	184.2	232.7	177.8	277.4	124.2	345.9	3671.3
1967/68	540.8	236.0	332.0	370.3	98.8	403.6	94.0	142.2	98.6	141.7	124.7	265.9	2848.6
1968/69	449.6	184.2	130.0	228.3	83.6	51.6	108.7	102.6	213.4	199.4	165.1	262.9	2179.4
1969/70	385.8	343.9	201.7	260.4	322.8	193.8	246.9	149.4	160.0	379.0	172.5	378.0	3194.2
1970/71	517.7	313.7	181.1	348.5	290.0	202.7	103.9	168.7	121.6	99.0	226.7	124.6	2698.2
1971/72	555.1	304.4	433.7	363.4	165.5	137.0	277.1	350.9	239.0	195.0	186.2	40.5	3247.8
1972/73	186.0	385.0	397.0	277.3	293.8	208.8	156.0	156.6	260.0	147.9	230.0	276.0	2974.4
1973/74	114.2	468.5	378.0	799.8	322.5	126.9	11.1	185.2	130.6	255.6	254.0	272.5	3318.9
1974/75	103.6	454.7	715.2	698.6	158.1	106.5	165.0	27.6	160.5	204.0	126.5	367.5	3287.8
1975/76	260.0	297.0	263.0	612.5	285.8	321.8	240.0	306.0	172.0	131.4	64.5	163.8	3117.8
1976/77	353.3	365.0	174.5	223.3	172.2	340.2	352.0	103.7	61.5	154.7	149.8	509.7	2959.9
1977/78	390.5	416.9	226.0	265.0	217.0	411.5	33.8	24.9	154.0	122.9	145.6	555.0	2963.1
1978/79	321.7	631.2	210.0	230.0	77.6	430.0	163.4	117.7	161.0	200.0	251.0	398.1	3191.7
1979/80	329.0	503.0	381.8	190.6	171.0	173.5	19.3	26.5	255.5	229.0	213.1	531.0	3023.3
1980/81	331.8	369.0	630.0	440.0	270.5	327.7	27.5	224.3	227.7	165.9	91.5	500.7	3606.6
1981/82	345.0	594.5	127.0	318.4	329.0	345.6	96.0	158.4	76.8	84.0	333.7	592.6	3401.0
1982/83	360.2	505.2	420.0	793.4	111.0	398.2	87.0	210.5	126.6	94.5	64.3	308.0	3478.9
1983/84	820.3	139.8	494.0	530.0	280.0	137.0	124.7	16.6	157.3	93.5	148.4	300.0	3241.6
1984/85	439.3	502.0	367.6	114.7	144.0	175.1	198.8	112.8	126.9	375.2	638.8	369.5	3564.7
1985/86	223.0	192.9	*576.9*	446.8	0.6	543.2	96.8	423.5	82.5	203.3	274.1	157.1	*3220.7*
1986/87	463.6	662.2	702.8	144.9	186.5	283.9	99.0	124.7	138.2	162.4	194.0	423.2	3585.4
1987/88	325.0	248.3	457.1	425.6	350.0	387.9	121.1	114.4	55.4	406.6	350.2	385.9	3627.5
1988/89	356.6	163.5	477.0	733.5	674.1	435.9	91.5	75.2	138.3	92.6	502.3	226.1	3966.6
1989/90	478.7	151.5	169.6	623.1	596.0	875.4	253.5	57.1	198.8	173.2	255.2	366.8	4198.9
1990/91	450.0	151.0	440.3	436.6	142.2	320.5	381.5	73.9	208.9	183.5	140.9	358.8	3288.1
1991/92	397.8	525.3	340.0	375.0	552.2	578.4	263.1	207.1	69.0	199.3	468.5	364.7	4340.4
1992/93	128.4	474.4	320.6										
μ	352.6	330.7	387.0	359.1	247.3	281.1	178.8	154.9	163.0	199.6	239.0	316.5	3202.3
SD	140.4	152.3	159.9	185.0	142.4	171.0	96.1	86.4	62.8	84.6	119.7	124.0	450.0
CV	39.8	46.1	41.3	51.5	57.6	60.8	53.8	55.8	38.5	42.4	50.1	39.2	14.1
skew	0.5	0.4	0.2	0.8	1.0	1.1	0.6	0.8	0.1	0.5	1.2	0.1	0.3
min	103.6	92.0	119.6	12.4	0.6	43.4	11.1	16.6	36.3	30.0	64.3	40.5	2179.4
Q1	282.0	192.9	263.0	223.3	144.0	162.1	103.9	94.0	126.6	144.5	148.4	255.3	2881.9
Me	353.3	313.7	386.1	328.9	217.0	267.2	165.0	153.9	160.5	195.0	228.1	305.8	3207.5
Q2	439.3	454.7	477.0	440.0	322.5	389.9	240.0	207.1	210.1	249.9	279.7	378.0	3510.0
max	820.3	662.2	715.2	799.8	674.1	875.4	458.2	423.5	317.5	406.6	638.8	592.6	4340.4

Station III (Loch Sloy):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1945/46				*378.9*	*190.2*	*150.0*	*95.5*	*63.3*	*275.6*	217.9	192.8	358.4	
1946/47	17.0	304.6	351.0	373.9	30.7	142.8	473.7	163.8	168.9	191.8	1.3	322.6	2542.1
1947/48	162.6	438.7	120.1	336.6	336.1	320.6	194.6	80.8	191.0	220.0	293.4	346.5	3040.8
1948/49	449.6	232.7	393.7	391.2	361.2	139.5	336.8	125.5	65.8	102.9	190.8	101.3	2890.9
1949/50	318.3	283.2	541.5	228.4	310.4	197.6	198.9	69.9	133.1	306.6	273.1	555.3	3416.2
1950/51	316.0	178.8	115.6	304.0	197.9	172.5	219.0	60.2	101.6	164.1	239.0	184.9	2253.6
1951/52	102.1	364.8	451.9	256.8	95.3	232.4	117.4	58.7	185.9	119.1	173.7	149.1	2307.2
1952/53	294.4	97.3	264.4	243.1	177.3	97.5	145.0	150.6	55.4	248.7	182.6	319.8	2276.2
1953/54	182.4	489.7	294.7	334.0	215.7	184.4	132.6	150.6	180.1	141.5	210.8	354.1	2870.6
1954/55	460.8	450.4	584.2	167.9	119.9	75.4	166.6	156.5	152.4	38.9	55.6	260.1	2688.7
1955/56	222.3	128.3	491.3	222.5	101.3	154.4	92.2	191.3	159.3	201.7	205.5	255.5	2425.5
1956/57	203.2	209.6	464.3	397.3	207.0	264.9	135.1	113.0	96.8	205.5	211.3	167.1	2675.2
1957/58	326.1	104.7	479.1	327.9	135.4	74.9	118.9	195.3	84.3	140.7	265.2	231.1	2483.7
1958/59	273.8	88.9	294.4	123.2	151.1	238.8	178.6	74.9	140.2	246.4	120.4	67.1	1997.8
1959/60	280.4	300.5	528.3	205.0	259.6	96.3	272.8	136.9	113.3	187.0	118.4	123.7	2622.1
1960/61	149.4	328.2	363.0	294.9	321.3	242.8	186.2	147.3	146.8	184.4	344.2	362.5	3070.9
1961/62	363.7	232.4	221.5	502.7	319.0	82.3	105.7	120.9	178.6	129.3	376.2	286.5	2918.8
1962/63	161.5	115.8	298.2	10.9	71.9	417.1	175.0	262.9	129.0	149.6	147.1	235.7	2174.7
1963/64	395.5	283.7	134.9	146.9	90.7	112.2	207.5	244.7	133.4	234.6	227.5	252.7	2464.3
1964/65	167.4	285.4	332.2	329.9	69.9	158.2	222.0	186.7	319.8	118.9	267.0	210.3	2667.7
1965/66	336.3	106.9	353.8	226.6	285.6	288.2	141.5	175.0	184.2	64.8	92.7	263.7	2519.3
1966/67	143.0	255.0	413.5	269.5	274.3	526.5	159.3	214.1	152.7	225.8	116.3	260.9	3010.9
1967/68	478.3	186.4	204.2	267.2	83.6	281.2	87.4	123.9	82.5	108.7	109.5	219.5	2232.4
1968/69	414.0	188.2	132.6	238.5	70.1	26.9	90.2	121.9	176.8	136.7	142.7	219.7	1958.3
1969/70	313.7	284.0	199.1	226.9	256.1	149.8	186.0	129.7	115.8	245.6	128.4	345.7	2580.8

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1970/71	389.4	317.3	214.6	319.2	209.5	166.2	87.4	133.4	97.7	83.9	164.4	92.2	2275.2
1971/72	390.6	197.8	299.3	326.3	189.9	97.8	255.3	261.2	237.7	140.2	123.9	22.8	2542.8
1972/73	145.4	304.7	306.5	269.5	247.2	170.2	97.0	159.0	213.7	102.3	197.5	149.4	2362.4
1973/74	94.3	339.4	326.1	*698.4*	*268.8*	*132.3*	*12.5*	*180.5*	*92.8*	*155.7*	*188.2*	*264.4*	*2753.4*
1974/75	*79.0*	*427.5*	*593.7*	538.0	118.0	83.4	115.7	35.6	115.5	189.4	74.7	361.4	*2732.0*
1975/76	171.1	267.4	136.4	405.0	218.5	290.5	113.4	253.2	127.9	130.2	18.6	126.1	2258.3
1976/77	292.9	280.3	137.6	175.3	201.5	274.1	216.8	99.8	45.6	102.9	120.7	376.7	2324.2
1977/78	319.4	372.7	191.8	243.2	142.7	331.8	36.1	20.6	126.6	132.8	139.8	358.8	2416.3
1978/79	216.4	498.9	205.1	213.4	71.2	355.0	89.5	76.9	100.0	120.3	242.3	274.2	2463.2
1979/80	302.5	467.8	354.7	152.1	171.9	162.3	15.0	10.6	200.6	222.3	194.0	433.0	2686.8
1980/81	253.4	273.1	454.0	345.2	206.3	325.5	15.1	174.4	139.3	138.1	48.3	403.9	2776.6
1981/82	289.3	462.3	91.3	247.1	275.2	338.5	67.6	152.0	72.7	55.6	296.1	404.4	2752.1
1982/83	303.7	418.3	396.4	628.2	83.9	295.7	80.0	145.1	97.4	40.6	43.9	304.0	2837.2
1983/84	592.3	111.3	438.8	437.5	233.3	93.3	112.1	*22.0*	117.9	65.1	114.6	218.8	*2557.0*
1984/85	425.0	430.6	368.5	107.7	110.6	132.7	181.4	104.6	101.4	322.4	*412.0*	360.7	*3057.6*
1985/86	233.8	*231.3*	*487.3*	408.3	3.3	424.3	114.7	361.3	84.4	144.5	175.1	81.9	*2750.2*
1986/87	330.0	489.1	596.7	130.1	170.8	273.4	78.4	100.4	85.6	85.8	204.0	328.4	2872.7
1987/88	268.7	191.4	379.3	380.5	308.1	365.7	105.9	114.6	44.3	321.1	322.3	291.4	3093.3
1988/89	314.1	164.7	333.1	523.3	539.9	431.2	82.9	62.5	112.2	65.5	376.2	207.5	3213.1
1989/90	342.5	111.3	159.7	563.0	587.3	678.1	191.1	52.5	168.4	127.8	151.3	226.2	3359.2
1990/91	387.1	151.1	330.7	355.2	110.0	247.0	373.8	37.3	172.0	141.1	110.4	290.4	2706.1
1991/92	323.4	428.8	267.7	290.0	401.3	456.5	187.5	167.4	35.2	171.5	489.9	317.0	3536.2
1992/93	161.0	427.4	254.5										
μ	279.9	283.0	326.6	309.8	204.3	233.0	150.4	132.8	134.3	157.2	189.2	262.7	2661.2
SD	117.7	124.4	138.6	139.6	122.2	136.1	90.6	72.7	55.1	70.3	105.6	107.9	358.8
CV	42.0	44.0	42.4	45.1	59.8	58.4	60.2	54.7	41.0	44.7	55.8	41.1	13.5
skew	0.1	0.1	0.2	0.7	1.0	1.0	1.3	0.7	0.8	0.6	0.7	0.0	0.4
min	17.0	88.9	91.3	10.9	3.3	26.9	12.5	10.6	35.2	38.9	1.3	22.8	1958.3
Q1	176.7	187.3	209.9	226.7	110.2	134.4	90.7	77.9	96.9	111.3	118.9	208.2	2418.6
Me	294.4	283.2	330.7	292.5	199.7	215.0	133.9	131.6	127.3	140.9	178.9	262.3	2671.5
Q2	339.4	395.5	426.2	378.9	272.9	314.3	190.2	172.7	168.8	199.2	241.5	341.4	2872.2
max	592.3	498.9	596.7	698.4	587.3	678.1	473.7	361.3	319.8	322.4	489.9	555.3	3536.2

Station IV (Loch Arklet, Corriehichon):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1904/05				124.5	170.2	279.4	124.5	88.9	78.7	127.0	218.4	149.9	
1905/06	142.2	241.3	254.0	350.5	203.2	177.8	88.9	190.5	30.5	170.2	248.9	132.1	2230.2
1906/07	276.9	208.3	185.4	165.1	221.0	200.7	116.8	213.4	185.4	81.3	279.4	81.3	2215.0
1907/08	157.5	170.2	279.4	254.0	172.7	195.6	55.9	124.5	132.1	188.0	203.2	353.1	2286.1
1908/09	91.4	208.3	248.9	251.5	134.6	53.3	205.7	139.7	94.0	144.8	147.3	96.5	1816.2
1909/10	345.5	160.0	266.7	284.5	276.9	162.6	210.8	96.5	63.5	213.4	353.1	71.1	2504.5
1910/11	121.9	119.4	289.6	190.5	393.7	66.0	208.3	132.1	165.1	142.2	248.9	109.2	2187.0
1911/12	193.0	307.4	373.4	256.6	284.5	276.9	147.3	99.1	210.8	119.4	172.7	121.9	2563.0
1912/13	254.0	259.1	718.8	208.3	218.4	312.4	177.8	165.1	132.1	30.5	63.5	124.5	2664.6
1913/14	172.7	345.5	236.2	205.7	353.1	256.6	195.6	96.5	52.1	120.7	196.9	128.3	2359.8
1914/15	88.9	304.8	326.4	195.6	304.8	135.9	181.6	44.5	59.7	172.7	116.8	71.1	2002.9
1915/16	170.2	86.4	228.6	400.1	204.5	49.5	156.2	177.8	71.1	99.1	124.5	69.9	1837.8
1916/17	369.6	292.1	424.2	92.7	35.6	102.9	53.3	114.3	124.5	54.6	259.1	205.7	2128.6
1917/18	316.2	381.0	110.5	188.0	313.7	73.7	34.3	105.4	82.6	124.5	170.2	201.9	2101.9
1918/19	327.7	288.3	273.1	175.3	40.6	109.2	161.3	52.1	141.0	64.8	157.5	238.8	2029.5
1919/20	74.9	175.3	309.9	348.0	416.6	270.5	87.6	271.8	91.4	148.6	205.7	134.6	2535.0
1920/21	188.0	321.3	224.8	417.8	85.1	444.5	55.9	174.0	36.8	165.1	214.6	111.8	2439.8
1921/22	243.8	124.5	447.1	231.1	209.6	85.1	120.7	217.2	99.1	158.8	154.9	128.3	2220.0
1922/23	106.7	144.8	248.9	332.8	262.9	111.8	165.1	86.4	78.7	204.5	250.2	377.2	2369.9
1923/24	388.6	170.2	162.6	227.3	61.0	16.5	135.9	163.8	119.4	208.3	154.9	240.0	2048.6
1924/25	156.2	204.5	327.7	248.9	200.7	71.1	198.1	238.8	40.6	76.2	167.6	106.7	2037.2
1925/26	236.2	35.6	134.6	459.8	238.8	215.9	83.8	121.9	152.4	132.1	207.0	167.6	2185.8
1926/27	261.6	358.2	154.9	358.2	129.5	149.9	134.6	88.9	160.0	144.8	200.7	185.4	2326.7
1927/28	233.7	190.5	43.2	495.3	266.7	312.4	157.5	38.1	198.1	226.1	200.7	177.8	2540.1
1928/29	373.4	304.8	279.4	104.1	88.9	48.3	53.3	188.0	170.2	172.7	254.0	104.1	2141.3
1929/30	307.4	330.2	487.7	322.6	2.5	132.1	91.4	94.0	127.0	119.4	226.1	142.2	2382.6
1930/31	340.4	279.4	264.2	177.8	254.0	58.4	73.7	190.5	190.5	180.3	64.8	78.7	2152.7
1931/32	215.9	375.9	289.6	464.8	0.0	101.6	203.2	106.7	101.6	175.3	83.8	177.8	2296.3
1932/33	254.0	241.3	406.4	304.8	172.7	152.4	144.8	94.0	76.2	142.2	177.8	55.9	2222.6
1933/34	152.4	104.1	61.0	386.1	61.0	101.6	170.2	139.7	68.6	101.6	188.0	294.7	1828.9
1934/35	383.6	76.2	388.6	101.6	322.6	88.9	134.6	15.2	177.8	71.1	124.5	294.7	2179.4
1935/36	375.9	177.8	116.8	185.4	119.4	154.9	50.8	76.2	66.0	226.1	129.5	152.4	1831.4
1936/37	243.8	119.4	294.7	370.9	152.4	76.2	104.1	81.3	134.6	177.8	127.0	162.6	2044.8
1937/38	86.4	48.3	94.0	350.5	175.3	269.3	25.4	109.2	231.1	160.0	114.3	195.6	1859.4
1938/39	360.7	383.6	205.7	132.1	282.0	142.2	94.0	53.3	99.1	193.0	81.3	114.3	2141.3
1939/40	114.3	355.6	142.2	50.8	88.9	152.4	76.2	33.0	30.5	104.1	116.8	188.0	1452.9
1940/41	282.0	238.8	259.1	30.5	215.9	43.2	106.7	83.8	30.5	88.9	160.0	86.4	1625.7

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1941/42	241.3	248.9	106.7	200.7	99.1	129.5	114.3	152.4	68.6	177.8	256.6	287.0	2082.9
1942/43	248.9	48.3	355.6	256.6	210.8	121.9	215.9	114.3	190.5	119.4	297.2	198.1	2377.5
1943/44	495.3	139.7	134.6	271.8	101.6	38.1	142.2	185.4	175.3	127.0	182.9	215.9	2209.9
1944/45	213.4	299.7	304.8	96.5	411.5	195.6	101.6	190.5	221.0	162.6	91.4	271.8	2560.4
1945/46	213.4	35.6	243.8	315.0	167.6	81.3	78.7	58.4	182.9	193.0	180.3	294.7	2044.8
1946/47	17.8	317.5	236.2	287.0	12.7	127.0	350.5	149.9	157.5	165.1	0.0	241.3	2062.6
1947/48	139.7	398.8	73.7	309.9	284.5	248.9	175.3	76.2	177.8	175.3	342.9	330.2	2733.1
1948/49	373.4	177.8	358.2	307.4	279.4	114.3	254.0	127.0	55.9	96.5	180.3	121.9	2446.1
1949/50	330.2	248.9	414.0	190.5	332.8	172.7	147.3	71.1	114.3	264.2	248.9	444.5	2979.5
1950/51	289.6	160.0	86.4	198.1	177.8	109.2	152.4	63.5	101.6	154.9	231.1	177.8	1902.5
1951/52	78.7	330.2	309.9	203.2	88.9	241.3	116.8	66.0	172.7	109.2	185.4	129.5	2032.1
1952/53	228.6	78.7	210.8	203.2	177.8	88.9	134.6	132.1	48.3	241.3	139.7	304.8	1988.9
1953/54	226.1	406.4	261.6	228.6	165.1	215.9	96.5	152.4	144.8	134.6	221.0	317.5	2570.6
1954/55	403.9	398.8	485.2	147.3	106.7	50.8	160.0	137.2	129.5	27.9	43.2	213.4	2303.9
1955/56	198.1	132.1	429.3	190.5	80.3	121.9	76.2	147.3	139.7	215.9	200.7	238.8	2170.8
1956/57	149.9	116.8	342.9	353.1	190.5	238.8	96.5	111.8	76.2	190.5	200.7	137.2	2204.8
1957/58	269.3	91.4	266.7	241.3	91.4	73.7	124.5	172.7	99.1	134.6	231.1	193.0	1988.9
1958/59	233.7	78.7	256.6	76.2	111.8	223.5	149.9	58.4	104.1	208.3	99.1	54.6	1654.9
1959/60	221.0	219.7	365.8	124.5	209.6	85.1	268.0	137.2	108.0	184.2	137.2	106.7	2166.7
1960/61	137.2	294.7	273.1	255.3	256.5	172.7	200.7	156.2	94.0	156.2	315.0	265.4	2576.9
1961/62	309.9	184.2	154.9	419.1	289.6	48.3	63.5	83.8	154.9	160.0	322.6	289.6	2480.4
1962/63	106.7	100.3	232.4	6.4	67.3	411.5	186.7	193.0	115.6	121.9	123.2	208.3	1873.3
1963/64	254.0	215.9	109.2	123.2	82.6	111.8	180.3	208.3	124.5	201.9	194.3	235.0	2041.0
1964/65	133.4	222.3	311.2	270.5	39.4	132.1	171.5	154.9	238.8	133.4	224.8	233.7	2266.0
1965/66	301.0	95.3	304.8	196.9	254.0	181.6	133.4	171.5	165.1	50.8	87.6	203.2	2145.2
1966/67	148.6	179.1	334.0	260.4	270.5	355.6	105.4	227.3	123.2	203.2	110.5	240.0	2557.8
1967/68	402.6	148.6	156.2	215.9	96.5	250.2	100.3	133.4	63.5	105.4	105.4	250.2	2028.2
1968/69	363.2	151.1	123.2	207.0	52.1	16.5	76.2	123.2	184.2	130.8	105.4	194.3	1727.2
1969/70	221.0	254.0	194.3	207.0	260.4	118.1	152.4	108.0	102.9	237.5	114.3	247.7	2217.6
1970/71	356.9	293.4	152.4	308.6	181.0	98.0	85.0	150.0	80.0	105.0	167.0	87.0	2064.3
1971/72	385.0	200.0	260.0	295.0	186.0	108.0	222.0	281.0	170.0	120.0	111.0	16.0	2354.0
1972/73	131.0	273.0	304.0	240.0	200.0	126.0	83.0	157.0	193.0	90.0	179.0	161.0	2137.0
1973/74	87.0	297.0	264.0	641.0	257.0	100.0	9.0	185.0	80.0	149.0	179.0	200.0	2448.0
1974/75	63.0	364.0	505.0	532.0	107.0	90.0	106.0	26.0	80.0	175.0	70.0	302.0	2420.0
1975/76	182.0	250.0	129.0	360.0	190.0	264.0	90.0	260.0	113.0	93.0	19.0	153.0	2103.0
1976/77	294.0	266.0	148.0	167.0	216.0	286.0	168.0	93.0	45.0	107.0	135.0	273.0	2198.0
1977/78	355.0	292.0	175.0	230.0	132.0	275.0	38.0	15.0	111.0	105.0	101.0	317.0	2146.0
1978/79	215.0	388.0	216.0	212.0	50.0	337.0	98.0	89.0	86.0	102.0	183.0	304.0	2280.0
1979/80	315.0	380.0	327.0	115.0	146.0	166.0	13.0	13.0	196.0	181.0	180.0	358.0	2390.0
1980/81	202.0	265.0	418.0	307.0	163.0	281.0	16.0	185.0	132.0	125.0	42.0	374.0	2510.0
1981/82	280.0	357.0	89.0	230.0	269.0	292.0	61.0	108.0	80.0	54.0	226.0	369.0	2415.0
1982/83	300.0	363.0	327.0	482.0	70.0	260.0	81.0	170.0	90.0	31.0	47.0	292.0	2513.0
1983/84	510.0	78.0	278.0	380.0	200.0	101.0	87.0	16.0	100.0	44.0	96.0	220.0	2110.0
1984/85	382.0	*380.2*	298.0	103.0	73.0	125.0	160.0	95.0	97.0	313.0	447.0	358.0	*2831.2*
1985/86	212.0	173.0	*390.9*	347.0	1.0	365.0	92.0	373.0	66.0	178.0	182.0	85.0	*2464.9*
1986/87	300.0	487.0	625.0	110.0	149.0	219.0	72.0	79.0	106.0	89.0	170.0	272.0	2678.0
1987/88	263.0	181.0	300.0	382.0	255.0	261.0	113.0	100.0	29.0	348.0	240.0	261.0	2733.0
1988/89	287.0	120.0	266.0	413.0	530.0	326.0	90.0	55.0	124.0	74.0	339.0	210.0	2834.0
1989/90	243.0	134.0	194.0	539.0	550.0	475.0	140.0	50.0	155.0	104.0	165.0	184.0	2933.0
1990/91	377.0	113.0	332.0	318.0	116.0	227.0	311.0	30.0	163.0	132.0	86.0	242.0	2447.0
1991/92	265.0	352.0	252.0	283.0	356.0	360.0	180.0	153.0	40.0	155.0	332.0	335.0	3063.0
1992/93	114.0	356.0	237.0										
μ	244.0	230.3	266.8	259.1	187.5	173.5	127.6	125.6	116.7	144.2	175.4	202.9	2255.8
SD	103.3	107.1	121.1	121.1	111.8	102.7	63.7	66.4	51.9	59.1	81.3	91.4	305.9
CV	42.3	46.5	45.4	46.7	59.6	59.2	49.9	52.9	44.4	41.0	46.4	45.1	13.6
skew	0.1	0.1	0.8	0.5	0.7	0.8	0.8	0.8	0.3	0.5	0.5	0.3	0.2
min	17.8	35.6	43.2	6.4	0.0	16.5	9.0	13.0	29.0	27.9	0.0	16.0	1452.9
Q1	157.2	143.5	182.8	189.9	98.4	99.5	84.7	83.2	78.7	104.8	116.2	128.3	2055.6
Me	243.4	230.5	264.1	245.1	179.4	146.1	118.7	118.1	109.5	142.2	178.4	199.1	2215.0
Q2	315.3	309.9	327.0	336.3	257.9	251.8	165.8	166.3	158.1	177.9	221.9	271.8	2447.5
max	510.0	487.0	718.8	641.0	550.0	475.0	350.5	373.0	238.8	348.0	447.0	444.5	3063.0

Station V (Doune, Inverbeg):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1960/61				310.6	284.7	153.2	200.4	150.9	113.0	155.4	288.3	321.6	
1961/62	357.1	224.5	205.0	446.3	245.4	79.0	116.8	111.3	166.4	146.3	328.9	290.8	2717.8
1962/63	148.3	111.0	306.6	17.5	62.2	421.1	172.5	261.4	120.7	152.4	144.3	164.3	2082.3
1963/64	285.5	288.8	122.4	*130.3*	*92.4*	*120.4*	*157.3*	*224.6*	*111.4*	*165.3*	*188.6*	*225.6*	*2112.5*
1964/65	*137.9*	*239.4*	*269.1*	318.3	31.5	167.1	182.6	186.7	242.3	124.2	253.0	248.7	*2400.8*
1965/66	314.2	110.5	365.3	174.2	264.4	247.1	137.7	211.1	148.6	63.5	107.4	212.3	2356.3
1966/67	147.1	230.9	384.3	263.9	316.5	409.2	138.4	204.5	145.0	202.2	124.7	258.8	2825.5
1967/68	455.9	162.3	151.1	232.9	103.1	257.8	105.2	138.7	70.6	94.2	126.2	271.3	2169.3

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1968/69	377.7	189.0	127.5	227.6	67.4	34.5	92.6	143.5	160.8	112.9	129.7	178.8	1842.0
1969/70	240.4	257.6	211.7	241.7	257.8	*152.8*	*137.7*	*123.1*	*103.4*	*197.6*	117.4	300.8	*2341.9*
1970/71	285.3	313.3	130.8	286.8	190.1	95.0	55.7	115.7	86.0	83.1	122.2	67.2	1831.2
1971/72	313.8	149.0	218.2	209.6	142.6	83.0	230.0	261.3	188.0	95.9	92.7	21.0	2005.1
1972/73	123.1	230.6	272.6	190.6	197.2	126.8	87.3	121.8	173.3	82.5	160.4	121.8	1888.0
1973/74	103.4	253.3	289.3	464.4	212.9	96.6	10.3	129.8	94.8	140.5	185.9	204.9	2186.1
1974/75	81.8	306.2	437.4	493.5	106.0	86.9	111.3	37.6	80.5	173.5	75.8	282.3	2272.8
1975/76	151.9	232.2	108.3	298.6	167.4	281.7	98.9	245.5	116.0	123.4	30.1	119.4	1973.4
1976/77	254.4	256.2	109.5	151.8	244.3	254.8	160.4	70.4	55.4	100.2	118.8	288.1	2064.3
1977/78	280.6	340.1	164.5	206.8	157.8	300.2	37.5	12.5	106.1	162.6	140.6	252.8	2162.1
1978/79	145.6	380.1	147.2	167.6	55.7	312.7	91.0	67.2	80.9	99.8	238.9	182.0	1968.7
1979/80	283.2	356.1	317.4	137.6	159.3	142.8	7.7	12.9	175.8	192.9	188.9	362.8	2337.4
1980/81	234.5	228.8	367.6	244.8	166.4	217.2	11.6	162.0	99.0	144.6	28.6	376.8	2281.9
1981/82	281.5	335.8	57.4	235.9	268.0	339.5	66.0	101.4	84.2	44.9	193.4	325.9	2333.9
1982/83	*271.6*	376.2	315.9	446.9	81.0	264.7	72.5	148.3	88.8	27.3	39.5	320.7	*2453.4*
1983/84	407.1	74.6	294.0	368.1	171.6	83.7	85.8	17.4	90.1	60.6	59.9	219.0	1931.9
1984/85	313.9	359.4	292.8	89.5	77.8	100.3	*139.8*	*103.2*	*89.4*	*262.8*	*421.2*	*338.7*	*2588.9*
1985/86	*220.5*	*203.3*	*395.1*	378.9	7.5	447.7	119.3	381.8	65.5	120.2	196.6	60.2	*2596.6*
1986/87	315.2	473.5	522.3	79.0	139.1	240.2	73.0	114.3	95.8	80.0	186.7	290.2	2609.3
1987/88	279.0	217.2	289.5	364.2	278.9	311.7	101.5	101.1	34.6	349.7	291.3	222.6	2841.3
1988/89	315.1	145.6	271.2	460.7	462.6	393.4	83.7	56.2	112.1	60.1	279.4	180.7	2820.8
1989/90	303.0	108.4	155.2	500.1	556.0	472.8	170.4	61.0	167.6	115.0	141.8	170.3	2921.6
1990/91	375.5	104.4	299.6	314.9	114.9	215.5	326.0	24.0	172.6	126.8	80.5	185.1	2339.8
1991/92	289.1	374.3	248.1	216.8	348.0	359.4	178.1	152.3	35.6	175.3	383.8	284.5	3045.3
1992/93	148.8	350.1	240.8										
μ	257.6	249.5	252.7	271.0	188.5	227.2	117.5	132.9	114.8	132.4	170.8	229.7	2332.3
SD	93.7	99.1	108.0	127.4	121.7	124.2	66.9	84.0	47.4	65.1	98.4	88.5	339.6
CV	36.4	39.7	42.7	47.0	64.6	54.7	56.9	63.2	41.3	49.2	57.6	38.5	14.6
skew	-0.1	0.1	0.3	0.2	1.1	0.4	0.8	0.8	0.6	1.3	0.8	-0.6	0.4
min	81.8	74.6	57.4	17.5	7.5	34.5	7.7	12.5	34.6	27.3	28.6	21.0	1831.2
Q1	151.1	182.3	154.2	186.5	100.4	115.4	81.0	69.6	85.6	91.4	114.9	180.2	2073.3
Me	281.1	235.8	270.2	243.3	166.9	228.7	108.3	122.4	104.7	123.8	143.1	237.1	2333.9
Q2	314.0	336.9	308.9	365.2	259.5	312.0	158.1	168.2	151.7	163.3	207.2	290.4	2592.7
max	455.9	473.5	522.3	500.1	556.0	472.8	326.0	381.8	242.3	349.7	421.2	376.8	3045.3

Station VI (Sallochy):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1960/61				201.7	241.0	108.0	149.6	118.1	68.8	119.6	233.7	262.1	
1961/62	262.9	152.1	175.5	335.8	173.7	45.0	89.2	93.5	101.9	112.0	263.4	245.1	2050.1
1962/63	85.9	97.8	194.6	25.7	66.3	304.5	91.4	182.1	82.3	121.9	119.6	139.7	1511.8
1963/64	213.1	251.5	85.9	86.9	41.1	103.8	175.4	195.7	91.5	135.5	162.8	173.4	1716.6
1964/65	124.1	197.0	195.3	215.9	41.4	86.6	128.0	130.6	195.6	108.2	143.5	216.2	1782.4
1965/66	244.3	127.8	267.7	191.8	200.9	130.0	137.7	141.5	157.7	49.5	121.4	178.8	1949.1
1966/67	118.9	173.2	310.1	184.7	192.8	258.8	90.4	188.0	85.3	147.6	94.2	167.1	2011.1
1967/68	367.0	115.1	117.3	167.1	82.3	172.7	70.4	170.9	48.3	95.0	115.1	203.5	1724.7
1968/69	338.3	136.4	0.0	187.0	68.8	40.1	73.9	149.5	142.8	75.3	93.9	131.1	1437.1
1969/70	141.7	198.8	146.0	159.0	153.6	83.6	137.1	90.3	104.8	147.8	133.4	238.2	1734.3
1970/71	261.4	286.9	123.9	232.7	159.6	86.4	69.4	101.6	76.8	88.4	132.0	61.0	1680.1
1971/72	266.4	152.3	184.8	254.4	149.2	79.4	183.8	230.0	160.5	85.5	69.3	13.7	1829.3
1972/73	107.8	248.7	248.6	174.2	158.5	94.7	71.2	121.2	161.5	76.2	125.2	120.2	1708.0
1973/74	94.6	230.5	258.0	404.9	191.9	101.0	21.8	116.6	75.3	96.8	152.2	202.7	1946.3
1974/75	65.3	263.4	363.5	417.2	108.8	69.5	90.6	28.6	70.0	152.6	62.2	259.8	1951.5
1975/76	136.0	214.5	89.5	246.5	166.0	255.5	83.5	235.0	98.1	124.8	25.0	131.0	1805.4
1976/77	276.1	215.6	138.4	183.5	274.0	204.3	120.2	80.7	52.8	84.6	109.6	241.7	1981.5
1977/78	260.5	248.1	132.2	174.9	138.6	226.8	51.4	15.3	115.4	119.6	116.9	190.0	1789.7
1978/79	116.7	276.2	183.0	*150.2*	*40.9*	*247.3*	*80.3*	*91.8*	*80.9*	*76.7*	*147.9*	*229.9*	*1721.8*
μ	193.4	199.2	178.6	210.2	139.4	142.0	100.8	130.6	103.7	106.2	127.4	179.2	1796.2
SD	93.1	58.6	87.9	95.0	68.4	82.1	42.1	60.1	41.3	28.7	54.5	67.3	166.0
CV	48.2	29.4	49.2	45.2	49.1	57.8	41.8	46.0	39.8	27.0	42.7	37.5	9.2
skew	0.3	-0.2	0.2	0.7	0.1	0.7	0.4	0.0	0.8	0.0	0.8	-0.9	-0.4
min	65.3	97.8	0.0	25.7	40.9	40.1	21.8	15.3	48.3	49.5	25.0	13.7	1437.1
Q1	117.3	152.2	126.0	170.7	75.6	85.0	72.6	92.6	76.1	85.1	101.9	135.4	1717.9
Me	177.4	206.7	179.3	187.0	153.6	103.8	90.4	121.2	91.5	108.2	121.4	190.0	1786.1
Q2	262.5	248.6	235.3	239.6	182.8	215.6	132.6	176.5	129.1	123.4	145.7	234.0	1948.4
max	367.0	286.9	363.5	417.2	274.0	304.5	183.8	235.0	195.6	152.6	263.4	262.1	2050.1

Station VII (Arrochymore):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1969/70				132.6	129.1	74.9	128.8	62.9	96.6	126.1	126.9	191.1	
1970/71	231.1	228.1	106.0	143.4	126.2	61.1	59.7	63.7	53.5	93.3	132.9	51.5	1350.5

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1971/72	233.4	113.5	128.9	173.5	116.9	70.5	120.2	165.5	129.4	66.1	60.8	12.1	1390.8
1972/73	55.0	138.9	165.3	156.8	115.0	67.9	70.0	103.7	117.8	61.3	112.4	108.1	1272.2
1973/74	76.9	209.9	217.0	298.5	137.7	89.2	20.3	86.0	50.4	93.8	109.3	169.8	1558.8
1974/75	41.4	213.6	278.9	301.6	70.6	40.3	71.4	23.3	71.1	126.3	56.9	203.6	1499.0
1975/76	126.6	153.7	48.5	222.2	126.2	187.3	47.8	178.6	97.5	77.6	11.7	101.0	1378.7
1976/77	181.7	156.0	101.4	88.3	189.5	160.7	112.9	43.7	75.9	66.9	108.8	216.8	1502.6
1977/78	192.7	206.2	103.7	182.9	122.9	185.9	47.0	14.0	93.1	85.8	126.1	204.8	1565.1
1978/79	97.4	274.2	167.1	143.1	32.3	206.3	92.6	48.9	57.5	79.3	177.3	142.6	1518.6
1979/80	206.4	280.5	200.8	125.1	123.1	143.0	6.5	17.1	150.0	182.7	145.1	254.0	1834.3
1980/81	165.6	230.2	271.7	145.6	107.1	201.6	13.8	113.0	97.0	99.2	29.6	283.8	1758.2
1981/82	211.4	238.8	56.1	140.2	108.5	193.7	44.0	76.6	74.6	27.6	143.2	211.9	1526.6
1982/83	175.2	239.7	219.6	298.5	49.9	182.9	69.5	99.1	65.7	27.5	41.8	256.2	1725.6
1983/84	304.0	49.6	265.2	274.3	123.1	85.1	64.0	21.8	67.7	21.3	62.4	145.1	1483.6
1984/85	292.4	209.2	165.5	84.5	51.8	90.2	108.4	74.5	62.2	242.4	281.7	291.0	1953.8
1985/86	69.0	161.2	287.9	221.4	20.5	226.7	83.7	207.7	68.6	84.4	126.7	57.0	1614.8
1986/87	200.2	311.0	294.2	93.2	122.5	207.6	52.8	71.6	97.1	64.4	140.8	169.5	1824.9
1987/88	168.3	111.0	203.6	243.9	138.1	186.2	96.5	83.7	24.4	228.7	208.7	187.8	1880.9
1988/89	208.0	127.8	152.7	185.0	255.9	230.7	71.1	41.8	91.5	40.8	218.2	106.3	1729.8
1989/90	190.0	58.6	130.0	336.9	271.2	275.0	99.8	45.9	138.2	74.4	123.5	109.2	1852.7
1990/91	247.1	81.8	213.2	186.4	91.9	164.7	152.5	13.9	150.6	109.6	57.3	145.7	1614.7
1991/92	182.4	198.5	187.5	175.0									
μ	175.3	181.5	180.2	189.3	119.5	151.4	74.2	75.3	87.7	94.5	118.3	164.5	1611.2
SD	71.9	71.9	73.0	73.4	60.8	67.1	37.7	53.4	33.4	58.5	65.4	75.1	192.3
CV	41.0	39.6	40.5	38.8	50.9	44.3	50.7	70.8	38.0	61.9	55.3	45.7	11.9
skew	-0.3	-0.2	-0.1	0.5	0.9	-0.2	0.1	1.1	0.4	1.3	0.6	-0.2	0.1
min	41.4	49.6	48.5	84.5	20.5	40.3	6.5	13.9	24.4	21.3	11.7	12.1	1272.2
Q1	136.4	130.6	129.2	141.7	95.7	86.1	49.1	42.3	66.2	64.8	61.2	108.4	1499.0
Me	186.2	202.4	177.3	175.0	122.7	173.8	70.6	67.7	83.7	81.9	124.8	169.7	1565.1
Q2	210.6	229.7	219.0	233.1	128.4	199.6	99.0	95.8	97.4	107.0	142.6	210.1	1758.2
max	304.0	311.0	294.2	336.9	271.2	275.0	152.5	207.7	150.6	242.4	281.7	291.0	1953.8

Station VIII (Glen Finlas, resr. no.2 and resr. South):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1910/11				175.0	282.5	67.8	135.6	116.8	121.9	139.2	102.1	177.8	
1911/12	156.2	221.0	275.6										
1912/13													
1913/14													
1914/15				163.8	152.4	165.1	123.2	25.9	67.8	187.7	108.0	76.2	
1915/16	121.9	80.0	131.3										
1916/17													
1917/18				184.9	246.4	68.6	73.9	123.2	76.2	157.0	165.6	210.8	
1918/19	269.8	253.5	225.6	184.2	24.1	97.5	106.9	53.6	128.5	41.7	179.8	184.2	1749.4
1919/20	53.1	124.2	252.7	210.8	249.9	251.2	80.5	217.4	94.2	127.3	213.6	174.3	2049.4
1920/21	97.3	214.1	127.8	323.4	84.3	265.2	74.4	107.4	80.8	110.5	302.3	102.4	1889.8
1921/22	206.0	135.9	370.1	180.1	168.9	94.7	103.9	178.6	107.2	178.6	151.4	103.9	1979.2
1922/23	134.6	229.1	202.7	251.0	146.8	96.0	117.6	80.5	76.7	182.4	272.3	304.6	2094.3
1923/24	295.7	130.6	152.7	211.8	62.2	19.6	100.8	161.6	147.8	214.1	166.6	217.2	1880.7
1924/25	164.6	173.2	233.2	213.9	128.0	67.8	195.1	284.2	43.7	81.3	174.0	153.7	1912.7
1925/26	189.7	35.1	130.3	260.6	244.9	176.8	73.4	117.9	106.7	118.1	186.2	183.6	1823.3
1926/27	200.7	185.4	147.8	252.0	176.8	191.0	150.6	112.0	213.6	147.8	181.9	232.9	2192.6
1927/28	203.0	208.3	39.1	403.9	188.5	135.1	108.5	57.2	233.9	188.0	216.2	156.2	2137.7
1928/29	264.7	318.0	196.9	72.6	82.6	69.3	42.4	133.4	154.2	175.5	293.4	109.2	1912.2
1929/30	262.1	274.1	372.1	228.9	11.7	124.5	70.6	115.3	114.6	128.5	251.5	118.4	2072.2
1930/31	280.2	240.5	189.5	235.5	239.5	46.5	107.7	208.5	267.7	182.4	95.5	61.7	2155.3
1931/32	246.4	294.9	277.6	406.7	0.8	116.8	219.7	114.6	65.8	195.3	124.7	223.0	2286.3
1932/33	281.7	303.5	388.6	259.3	200.9	116.6	151.9	106.4	104.1	206.5	217.4	29.7	2366.9
1933/34	143.0	105.9	61.0	424.7	82.0	117.4	111.5	160.5	94.0	98.6	166.1	267.5	1832.2
1934/35	364.5	93.2	283.2	128.0	260.1	90.7	128.5	19.6	168.4	108.5	150.6	309.1	2104.5
1935/36	431.3	176.3	164.1	186.4	125.5	133.1	76.7	70.1	97.8	231.1	191.3	151.9	2035.6
1936/37	262.9	178.6	328.9	280.2	194.6	64.0	98.3	62.5	193.6	251.2	172.0	201.7	2288.4
1937/38	107.2	53.9	132.1	352.6	189.0	244.4	50.3	238.5	293.4	211.3	134.4	252.0	2258.9
1938/39	439.4	389.4	224.0	159.3	289.8	163.6	109.2	53.9	137.9	274.3	77.0	194.1	2511.9
1939/40	86.1	353.8	167.9	68.6	111.0	217.4	103.4	41.1	30.7	114.1	137.9	162.6	1594.7
1940/41	255.0	286.5	259.9	27.4	188.7	83.1	88.6	94.2	61.2	136.4	228.4	94.2	1803.7
1941/42	231.4	170.2	146.6	220.5	64.5	108.7	105.7	104.9	85.6	157.0	326.1	312.7	2033.9
1942/43	357.4	62.0	345.5	201.7	235.5	118.9	192.5	142.5	188.2	133.1	358.7	195.6	2531.5
1943/44	483.4	175.8	134.9	298.5	115.1	36.8	132.3	187.0	208.8	157.5	131.1	196.3	2257.4
1944/45	218.2	273.8	216.9	141.7	351.3	185.4	90.7	166.4	194.1	167.9	80.8	269.0	2356.2
1945/46	227.8	32.0	172.5	276.1	178.3	122.4	94.2	48.0	193.6	156.7	178.1	298.5	1978.2
1946/47	23.1	280.2	260.4	271.3	20.8	131.8	256.0	162.3	160.5	194.1	0.0	231.4	1991.9
1947/48	125.2	385.8	121.9	295.7	231.4	208.0	142.8	67.6	201.4	215.4	357.1	361.2	2713.6
1948/49	456.7	186.7	252.2	317.3	232.7	122.9	280.7	101.6	52.3	121.4	176.3	114.6	2415.4
1949/50	269.8	224.0	433.1	176.3	274.8	140.5	177.8	62.2	115.3	285.8	241.8	431.8	2833.2
1950/51	276.9	126.8	77.0	222.3	120.7	146.8	133.4	66.3	72.6	158.5	227.3	165.9	1794.3
1951/52	91.7	274.3	375.9	212.4	92.7	180.6	94.5	55.4	142.2	135.1	203.7	144.8	2003.4
1952/53	187.5	100.1	248.9	149.9	161.0	77.7	90.4	113.5	63.8	299.7	195.3	283.5	1971.4

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1953/54	166.6	393.7	237.0	232.7	162.3	132.1	123.7	140.2	180.3	159.8	244.4	315.5	2488.3
1954/55	413.8	273.1	331.2	114.3	97.0	43.7	171.7	151.6	148.6	41.1	47.0	262.9	2096.1
1955/56	198.6	123.4	358.2	168.4	62.2	140.5	72.1	154.7	118.4	214.4	225.3	214.6	2050.9
1956/57	178.3	102.1	290.3	324.4	117.1	299.2	102.1	116.8	103.1	235.2	183.4	160.5	2212.7
1957/58	288.8	88.9	286.8	203.2	103.6	56.4	92.5	172.5	99.6	183.1	259.1	170.7	2005.2
1958/59	191.5	111.3	197.6	90.4	106.9	171.5	154.2	56.9	107.4	266.2	98.8	108.2	1661.0
1959/60	206.5	215.1	329.7	136.9	174.0	104.9	223.0	118.9	138.9	220.7	99.3	126.0	2094.1
1960/61	125.7	219.0	284.0	269.5	275.6	146.3	200.4	125.2	117.9	198.4	303.8	281.2	2547.0
1961/62	271.5	191.0	176.8	*360.7*	*193.1*	*47.6*	*108.7*	*90.1*	*155.1*	*177.4*	*360.6*	*276.0*	*2408.4*
1962/63	*114.5*	*99.3*	*272.4*	*20.8*	*60.9*	*287.3*	*137.8*	*195.1*	*117.7*	*188.6*	*161.0*	*156.6*	*1812.0*
1963/64	*248.5*	*256.7*	*114.1*	*93.8*	*47.1*	*99.6*	*208.4*	*158.3*	*114.6*	*187.1*	*223.4*	*211.3*	*1962.8*
1964/65	*143.6*	*205.3*	*234.1*	152.1	202.4	246.1	108.7	172.0	164.8	85.9	109.7	201.2	*2026.0*
1965/66	174.8	218.7	336.0	*172.9*	*215.5*	*143.2*	*146.5*	*155.2*	*179.5*	*77.6*	*142.3*	*201.4*	*2163.5*
1966/67	*133.4*	*190.4*	*384.7*	*206.0*	*232.3*	*259.8*	*120.2*	*172.5*	*133.0*	*239.8*	*132.8*	*215.7*	*2420.6*
1967/68	*412.6*	*130.3*	*148.2*	*183.9*	*86.2*	*168.7*	*92.3*	*135.9*	*68.9*	*131.1*	*148.1*	*242.7*	*1949.1*
1968/69	*361.9*	*153.0*	*60.4*	*192.3*	*64.4*	*31.4*	*88.0*	*128.7*	*177.1*	*128.6*	*135.3*	*158.2*	*1679.4*
1969/70	*187.1*	*215.4*	*195.7*	*183.3*	*187.4*	*43.6*	*77.3*	*39.4*	*64.4*	*109.5*	*156.0*	*276.5*	*1735.6*
1970/71	*276.8*	*285.9*	*142.9*	*240.7*	*163.1*	*74.1*	*67.0*	*95.5*	*95.0*	*119.1*	*157.7*	*66.3*	*1784.2*
1971/72	*292.1*	*144.4*	*224.1*	205.0	172.0	80.0	181.0	226.5	188.5	114.0	133.0	29.0	*1989.6*
1972/73	122.6	244.0	221.0	201.0	190.0	129.1	82.8	153.0	178.0	88.0	196.4	144.5	1950.4
1973/74	105.0	293.8	349.4	348.0	155.4	132.4	13.1	123.1	90.8	226.8	215.5	182.4	2235.7
1974/75	97.5	283.1	519.9	406.2	134.1	58.3	129.8	50.0	97.6	191.7	90.6	264.3	2323.1
1975/76	178.7	201.3	125.3	251.2	167.3	249.6	106.9	216.3	135.3	122.5	22.5	145.0	1921.9
1976/77	274.4	275.8	153.7	180.3	185.4	198.3	150.0	90.0	75.0	138.4	150.0	352.6	2223.9
1977/78	278.2	270.0	168.0	204.3	150.0	314.0	92.4	25.0	110.0	129.9	177.3	279.0	2198.1
1978/79	179.6	358.4	191.4	166.6	65.0	223.8	120.0	85.0	75.0	110.0	188.3	217.1	1980.2
1979/80	244.8	350.0	280.0	113.4	147.1	174.6	9.6	18.6	240.1	256.3	213.1	296.9	2344.5
1980/81	220.0	263.9	420.0	220.0	170.0	212.4	22.0	188.4	101.9	140.5	47.6	315.1	2321.8
1981/82	290.0	320.0	69.8	243.6	151.2	250.0	49.5	110.0	110.0	32.6	210.8	290.0	2127.5
1982/83	168.9	196.2	192.6	400.0	98.5	262.0	101.3	113.1	92.2	40.5	51.9	286.5	2003.7
1983/84	432.3	68.8	230.7	400.0	190.0	67.8	46.2	23.8	107.8	62.6	91.5	235.0	1956.5
1984/85	374.2	230.7	141.3	105.0	29.6	95.1	90.7	*87.7*	*100.3*	*328.4*	*375.6*	*380.1*	*2338.7*
μ	229.3	207.6	228.8	220.3	153.8	140.1	115.5	117.5	127.8	161.6	178.4	207.4	2101.9
SD	103.6	89.8	100.3	91.5	75.4	73.2	52.7	58.2	54.6	63.6	80.6	84.2	254.3
CV	45.2	43.3	43.8	41.5	49.0	52.2	45.6	49.6	42.7	39.4	45.2	40.6	12.1
skew	0.5	0.0	0.5	0.3	0.1	0.5	0.8	0.4	0.8	0.2	0.4	0.1	0.5
min	23.1	32.0	39.1	20.8	0.8	19.6	9.6	18.6	30.7	32.6	0.0	29.0	1594.7
Q1	156.2	130.6	148.2	169.5	97.4	80.8	88.1	68.2	92.6	119.7	132.8	154.3	1949.7
Me	218.2	214.1	224.0	208.4	161.7	130.5	106.9	114.9	114.6	157.2	175.1	201.5	2050.9
Q2	278.2	274.1	284.0	267.3	194.2	184.2	137.2	157.5	163.7	197.6	217.1	274.2	2272.6
max	483.4	393.7	519.9	424.7	351.3	314.0	280.7	284.2	293.4	328.4	375.6	431.8	2833.2

Station IX (Blairnairn No.1):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1932/33				188.0	182.9	118.4	105.9	126.0	87.4	213.4	170.9	33.0	
1933/34	132.6	117.1	55.4	268.0	30.5	107.4	120.4	145.8	113.0	73.7	147.8	201.4	1513.1
1934/35	307.4	84.3	295.4	133.9	209.6	77.0	158.5	27.4	135.1	101.6	91.7	227.8	1849.7
1935/36	316.5	162.6	181.4	149.6	118.9	111.8	62.5	70.6	93.5	171.7	144.3	153.9	1737.2
1936/37	181.4	144.3	248.4	239.5	164.6	114.6	87.1	51.1	121.4	122.4	134.1	126.2	1735.1
1937/38	129.3	36.8	138.4	252.5	153.4	187.5	25.9	145.8	188.2	198.9	101.1	185.9	1743.8
1938/39	310.9	302.5	252.5	164.3	199.1	145.8	95.0	49.0	101.1	199.4	93.5	121.4	2034.6
1939/40	121.4	272.6	143.0	73.7	91.4	121.9	114.3	41.9	21.6	92.7	125.2	120.1	1339.9
1940/41	193.8	225.3	198.9	65.3	191.3	92.0	66.6	125.2	45.5	103.6	172.2	89.7	1569.3
1941/42	184.2	174.3	113.5	190.5	69.9	107.4	82.3	122.7	70.4	97.3	216.9	217.9	1647.3
1942/43	247.4	47.5	207.5	190.0	201.4	115.1	120.4	118.1	145.5	103.4	249.2	140.5	1886.0
1943/44	280.2	103.1	102.4	201.7	93.5	74.9	107.4	110.0	160.0	143.0	135.9	155.7	1667.8
1944/45	195.8	219.0	209.3	163.1	269.0	132.8	69.9	168.4	163.3	162.3	72.1	206.5	2031.6
1945/46	214.1	25.4	186.4	214.6	120.1	106.4	66.8	63.5	161.0	125.7	140.7	332.8	1757.7
1946/47	20.3	314.0	289.6	214.1	25.4	139.7	309.9	189.0	133.4	185.4	0.0	205.0	2025.7
1947/48	127.3	292.1	76.2	370.9	184.7	185.4	109.2	85.6	200.7	164.1	302.3	330.2	2428.6
1948/49	361.7	198.1	294.7	335.3	175.3	172.7	188.0	91.4	45.5	88.4	188.0	114.3	2253.3
1949/50	254.0	213.4	383.0	179.1	188.0	134.6	134.6	58.4	82.6	184.2	200.7	341.9	2354.4
1950/51	217.2	127.0	70.6	184.4	127.5	131.3	89.9	80.3	65.3	100.6	172.2	130.1	1496.4
1951/52	57.2	234.5	316.2	368.3	88.9	131.1	87.4	51.3	102.4	113.5	145.5	105.4	1801.7
1952/53	158.8	103.6	209.8	83.8	77.5	61.7	97.5	123.2	44.5	160.8	134.4	158.8	1414.3
1953/54	120.1	270.0	187.0	209.6	198.9	125.2	105.9	137.2	119.4	131.8	167.6	272.3	2045.0
1954/55	315.5	241.3	236.2	236.2	180.6	115.6	89.2	113.8	111.3	114.6	54.9	28.7	1837.8
1955/56	145.5	155.5	216.4	86.1	59.9	94.5	53.3	106.7	80.0	156.2	167.6	158.2	1480.1
1956/57	143.8	82.8	235.2	209.1	133.4	177.8	82.6	84.1	75.2	178.3	127.0	85.1	1614.2
1957/58	149.6	58.7	208.8	171.7	96.5	53.3	61.0	127.0	91.4	152.4	228.6	184.2	1583.2
1958/59	282.5	196.9	294.7	68.8	80.5	149.6	113.3	76.2	207.3	231.1	50.0	53.3	1804.2
1959/60	104.7	188.7	235.0	163.8	130.1	112.8	152.4	101.6	110.5	155.5	117.6	93.0	1665.5
1960/61	103.6	185.4	185.7	189.5	160.3	85.6	149.9	107.4	96.5	100.1	205.7	205.7	1775.4
1961/62	190.5	122.4	147.3	299.7	151.6	71.1	89.4	83.8	91.9	144.8	230.4	208.3	1831.2
1962/63	92.7	101.6	180.3	15.2	63.5	210.8	104.1	152.4	108.0	96.5	117.6	142.2	1384.9

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1963/64	211.3	186.7	82.8	82.6	43.2	91.4	198.1	127.0	97.8	138.7	185.4	193.0	1638.0
1964/65	120.7	171.2	182.9	215.9	38.1	114.3	149.9	114.3	193.8	157.5	170.2	193.0	1821.8
1965/66	185.4	83.8	243.8	142.2	203.2	194.6	110.2	159.0	174.2	70.1	147.3	184.4	1898.2
1966/67	141.2	177.0	232.9	241.3	124.5	236.2	57.2	152.4	91.9	149.9	116.8	197.1	1918.4
1967/68	279.4	127.0	104.1	194.3	86.4	198.1	147.3	128.3	55.9	94.0	121.9	203.2	1739.9
1968/69	241.3	165.1	71.1	199.6	64.8	38.1	72.4	108.0	132.1	101.6	101.6	165.1	1460.8
1969/70	209.6	149.9	134.6	180.3	152.4	111.8	114.3	71.1	116.8	154.2	149.9	188.0	1732.9
1970/71	236.2	241.3	147.3	170.2	177.8	57.2	91.4	101.6	83.0	90.0	120.0	72.0	1588.0
1971/72	224.0	115.0	143.0	182.0	104.0	80.0	144.0	143.0	160.0	82.0	82.0	20.0	1479.0
1972/73	99.0	178.0	175.0	170.0	140.0	85.0	59.0	125.0	127.0	64.0	135.0	104.0	1461.0
1973/74	95.0	214.0	230.0	290.0	152.0	105.0	13.0	123.0	65.0	132.0	170.0	190.0	1779.0
1974/75	75.0	235.0	299.0	337.0	95.0	36.0	101.0	35.0	65.0	129.0	60.0	223.0	1690.0
1975/76	170.0	165.0	79.0	206.0	145.0	225.0	89.0	165.0	107.0	102.0	24.0	127.0	1604.0
1976/77	220.0	198.0	135.0	123.0	215.0	168.0	157.0	82.0	83.0	104.0	125.0	252.0	1862.0
1977/78	212.0	200.0	140.0	180.0	130.0	230.0	80.0	34.0	88.0	105.0	156.0	270.0	1825.0
1978/79	120.0	250.0	288.0	160.0	50.0	220.0	110.0	75.0	72.0	97.0	186.0	230.0	1858.0
1979/80	230.0	250.0	243.0	123.0	158.0	183.0	8.0	20.0	193.0	203.0	185.0	279.0	2075.0
1980/81	185.0	220.0	373.0	228.0	140.0	210.0	19.0	133.0	130.6	105.0	45.4	315.8	2104.8
1981/82	253.0	334.0	75.0	179.0	172.0	175.0	35.0	108.0	125.0	45.0	185.0	290.0	1976.0
1982/83	207.0	240.0	248.0	290.0	56.0	214.0	75.0	180.0	113.0	36.0	52.0	284.0	1995.0
1983/84	340.0	68.0	262.0	300.0	110.0	78.0	105.0	13.0	58.0	60.0	36.0	220.0	1650.0
1984/85	253.0	283.0	227.0	100.1	56.0	87.0	130.0	80.0	*83.5*	272.0	320.0	279.0	*2170.6*
1985/86	137.0	182.0	309.0	240.0	15.0	258.0	120.0	256.0	92.0	94.0	141.0	48.0	1892.0
1986/87	198.0	356.0	400.0	110.0	163.0	230.0	78.0	79.0	122.0	85.0	134.0	228.0	2183.0
1987/88	188.0	124.0	199.0	215.0	163.0	208.0	110.0	83.0	30.0	245.0	247.0	233.0	2045.0
1988/89	247.0	165.0	193.0	250.0	265.0	222.0	58.0	66.0	94.0	69.0	252.0	158.0	2039.0
1989/90	266.0	50.0	130.0	342.0	350.0	291.0	147.0	59.0	115.0	99.0	183.0	159.0	2191.0
1990/91	290.0	87.0	225.0	210.0	88.0	196.0	203.0	24.0	161.0	101.0	74.0	136.0	1795.0
1991/92	225.0	232.0	197.0	175.0	215.0	270.0	129.0	104.0	39.0	111.0	327.0	260.0	2284.0
1992/93	115.0	292.0	165.0										
μ	193.9	179.0	200.6	195.3	134.8	143.0	103.5	101.4	107.4	127.7	147.3	180.5	1814.7
SD	75.1	78.5	80.3	76.5	65.9	62.1	49.9	46.5	43.9	49.3	69.0	78.1	252.4
CV	38.7	43.8	40.0	39.2	48.9	43.4	48.2	45.9	40.9	38.6	46.8	43.3	13.9
skew	0.1	0.1	0.3	0.2	0.5	0.4	1.2	0.5	0.4	0.8	0.4	0.0	0.3
min	20.3	25.4	55.4	15.2	15.0	36.0	8.0	13.0	21.6	36.0	0.0	20.0	1339.9
Q1	131.8	121.1	142.3	162.3	87.6	93.9	74.4	71.0	81.9	96.9	113.0	126.8	1642.6
Me	194.8	180.0	198.9	189.7	136.7	128.1	102.6	105.3	101.7	112.3	142.6	187.0	1801.7
Q2	247.1	234.6	244.9	237.1	178.5	195.0	122.6	127.0	131.0	156.5	185.0	227.9	2010.4
max	361.7	356.0	400.0	370.9	350.0	291.0	309.9	256.0	207.3	272.0	327.0	341.9	2428.6

Station X (Balfron: High School, the Old Manse, Old Stables, Old Ballinkinrain):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1932/33				183.1	112.0	84.6	58.4	75.9	44.7	116.1	81.3	25.7	
1933/34	87.9	71.6	32.5	204.5	20.8	87.4	122.9	59.4	65.3	69.3	122.4	145.8	1090.0
1934/35	203.7	38.9	258.8	63.8	156.0	63.2	105.4	12.7	131.8	45.2	98.8	181.1	1359.5
1935/36	276.4	145.8	92.7	168.4	92.5	101.6	43.4	46.5	49.3	128.3	62.0	100.1	1306.9
1936/37	137.2	110.5	201.4	174.0	144.8	52.8	56.1	54.9	86.1	74.9	157.5	94.5	1344.7
1937/38	99.8	31.2	63.5	200.2	66.8	91.4	17.3	94.0	153.9	113.0	52.3	116.3	1099.9
1938/39	224.3	245.6	103.1	112.3	169.2	88.4	69.6	40.4	58.4	175.5	55.6	58.9	1401.4
1939/40	107.2	219.7	63.2	62.0	78.2	107.4	72.1	32.5	24.9	113.3	52.3	82.6	1015.5
1940/41	176.3	174.5	122.4	42.9	136.4	67.6	48.0	68.1	18.0	86.1	119.6	42.2	1102.1
1941/42	147.1	119.1	90.4	150.6	39.9	121.9	71.1	86.4	48.3	66.6	112.3	156.2	1209.8
1942/43	157.0	25.7	183.1	165.6	146.8	75.7	101.1	101.3	101.1	55.4	172.0	119.6	1404.4
1943/44	254.8	71.1	75.9	157.5	57.7	22.4	109.2	87.1	114.3	88.4	78.5	132.3	1249.2
1944/45	156.7	215.4	196.3	82.0	256.0	101.9	69.9	141.5	127.3	127.0	63.5	165.1	1702.6
1945/46	173.2	15.0	148.6	235.7	96.8	83.1	39.9	51.6	*96.1*	*97.4*	*84.9*	172.5	*1294.7*
1946/47	14.0	200.7	152.2	175.3	37.8	91.2	184.4	147.3	96.3	96.5	0.3	126.5	1322.4
1947/48	55.6	167.6	54.1	201.9	134.6	111.8	83.3	42.2	140.5	103.4	198.9	191.3	1485.2
1948/49	180.1	89.2	203.5	139.7	142.8	53.1	138.4	74.4	30.2	84.1	131.1	68.8	1335.3
1949/50	193.8	126.5	222.3	112.0	158.2	83.1	96.3	48.3	60.5	160.0	174.8	232.2	1667.8
1950/51	129.0	97.0	51.3	161.0	105.2	119.4	81.3	47.5	95.0	82.0	146.6	104.7	1220.0
1951/52	29.2	208.8	214.6	139.7	39.1	98.0	66.3	50.0	94.5	68.8	110.2	77.7	1197.1
1952/53	154.9	57.9	128.5	50.3	47.0	62.5	63.8	62.7	58.9	142.5	77.5	142.2	1048.8
1953/54	90.7	200.4	155.2	132.1	138.7	105.7	63.2	141.7	76.5	74.2	140.2	185.4	1504.0
1954/55	245.9	235.2	180.3	88.6	60.7	52.3	53.1	102.1	65.3	39.6	27.2	114.1	1264.5
1955/56	116.3	63.8	218.7	85.3	40.1	77.0	31.0	61.0	87.6	141.0	144.0	130.1	1195.9
1956/57	96.5	33.8	160.3	184.7	117.1	127.5	56.1	74.7	44.7	107.4	102.9	82.0	1187.8
1957/58	116.3	48.3	153.4	166.9	72.6	50.8	41.1	117.9	93.2	126.5	132.1	125.5	1244.6
1958/59	122.9	47.5	183.4	46.5	48.3	88.1	104.9	25.9	92.5	149.9	32.3	35.6	977.7
1959/60	117.9	164.9	223.8	103.9	129.8	76.5	118.6	88.9	55.6	83.6	85.9	73.7	1322.9
1960/61	102.1	174.8	146.8	153.9	145.0	59.7	138.2	72.4	41.4	95.5	156.5	152.7	1439.0
1961/62	160.0	117.9	131.3	253.5	113.5	43.9	61.5	61.5	65.5	98.0	160.5	162.3	1429.4

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1962/63	68.8	68.8	128.8	30.0	34.8	189.5	83.6	114.6	103.9	54.4	121.7	*86.9*	*1085.8*
1963/64	126.2	199.9	51.1	61.2	43.5	67.1	91.2	97.0	88.2	65.7	129.1	149.2	1169.4
1964/65	72.4	110.0	159.7	159.8	26.4	98.3	105.9	96.8	104.9	106.4	128.8	168.4	1337.8
1965/66	150.6	86.1	162.8	90.7	128.5	90.4	72.9	117.9	143.0	41.4	115.8	103.9	1304.0
1966/67	104.1	103.6	165.4	136.9	*132.0*	*138.1*	*46.4*	*104.4*	*50.0*	*90.0*	*62.6*	*128.1*	*1261.7*
1967/68	*261.0*	*88.3*	*74.8*	103.4	87.9	108.5	69.9	126.0	39.4	100.1	77.5	140.0	*1276.8*
1968/69	208.0	81.0	63.2	119.0	46.2	21.1	45.5	110.1	93.3	59.9	84.8	76.3	1008.4
1969/70	81.5	162.8	99.4	115.8	120.3	53.9	92.1	37.7	74.3	109.1	100.5	138.7	1186.1
1970/71	163.9	188.0	82.6	117.5	97.2	34.2	52.5	80.8	42.0	98.6	135.3	40.1	1132.7
1971/72	165.2	90.6	96.3	155.2	84.4	64.1	108.8	132.9	114.0	67.2	40.6	10.6	1129.9
1972/73	31.6	138.5	143.7	110.0	95.0	61.8	51.8	108.5	94.4	79.3	90.3	94.4	1099.3
1973/74	69.4	124.7	155.2	307.8	109.7	85.7	12.0	67.6	50.3	85.7	86.8	129.8	1284.7
1974/75	38.4	152.5	221.6	278.1	66.1	33.5	73.2	22.5	55.2	62.8	43.3	196.6	1243.8
1975/76	102.2	131.9	41.8	174.5	91.8	136.4	49.6	175.1	65.3	66.6	17.3	99.0	1151.5
1976/77	160.8	135.3	85.4	85.2	134.2	148.5	83.6	53.4	40.5	53.2	80.8	149.7	1210.6
1977/78	153.1	166.5	109.4	159.1	81.8	158.5	41.8	15.7	60.7	70.7	100.9	162.6	1280.8
1978/79	56.7	168.2	127.2	87.5	30.2	150.6	69.7	53.9	43.0	52.1	148.8	96.5	1084.4
1979/80	163.8	189.4	167.4	83.3	89.1	96.6	4.8	14.7	107.6	111.9	108.9	175.5	1313.0
1980/81	116.0	155.9	214.8	106.1	85.6	155.9	16.7	87.6	95.3	*94.6*	*22.6*	*273.1*	*1424.2*
1981/82	*190.0*	*193.7*	*45.9*	120.8	110.5	149.8	43.9	73.1	73.9	20.8	145.2	190.7	*1358.4*
1982/83	179.3	217.9	199.6	228.0	39.0	124.1	43.6	95.5	53.4	27.6	26.6	199.5	1434.1
1983/84	219.4	27.8	170.2	241.6	110.1	60.9	21.2	21.3	57.1	8.3	40.4	117.5	1095.8
1984/85	217.8	241.7	145.5	55.2	35.1	67.4	75.2	53.3	63.8	172.3	222.1	266.5	1615.9
1985/86	59.0	112.7	193.3	160.6	14.5	156.6	61.3	170.2	39.1	60.6	109.8	44.3	1182.0
1986/87	189.2	250.6	250.0	72.4	84.8	133.4	48.0	50.8	99.6	51.0	109.4	106.5	1445.7
1987/88	146.4	83.5	131.9	175.6	122.9	135.1	83.4	75.8	13.0	176.6	173.0	128.1	1445.3
1988/89	168.8	67.7	133.7	167.6	171.7	193.5	52.3	37.8	87.4	30.1	145.8	89.3	1345.7
1989/90	149.4	52.4	96.1	282.2	277.1	191.3	85.8	41.8	107.5	49.1	104.3	83.0	1520.0
1990/91	205.6	64.8	177.0	164.6	71.0	128.4	121.8	11.2	119.1	95.0	43.4	114.2	1316.1
1991/92	129.6	189.6	151.8	140.2	161.3	179.2	84.6	72.5	37.9	83.0	206.6	182.8	1619.1
1992/93	71.8	190.4	120.0										
μ	139.1	129.2	139.6	141.5	98.1	97.7	71.0	74.9	75.6	87.6	102.6	125.7	1284.5
SD	60.8	65.1	57.1	62.8	53.3	43.0	34.0	39.2	32.6	37.9	50.2	53.8	165.1
CV	43.7	50.4	40.9	44.4	54.3	44.0	47.9	52.4	43.2	43.3	48.9	42.8	12.8
skew	0.1	0.1	0.0	0.5	0.9	0.4	0.7	0.5	0.3	0.4	0.1	0.3	0.4
min	14.0	15.0	32.5	30.0	14.5	21.1	4.8	11.2	13.0	8.3	0.3	10.6	977.7
Q1	99.0	71.5	95.3	89.7	53.0	63.7	48.0	47.9	50.1	61.7	63.0	91.9	1175.7
Me	146.7	125.6	146.2	139.7	92.5	91.2	69.7	72.4	73.9	84.1	104.3	126.5	1280.8
Q2	177.0	188.4	181.0	171.2	133.1	128.0	88.5	99.2	96.2	106.9	137.8	162.5	1380.4
max	276.4	250.6	258.8	307.8	277.1	193.5	184.4	175.1	153.9	176.6	222.1	273.1	1702.6

Station XI (Loch Lomond):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1921/22				173.2	102.4	24.4	77.0	133.1	64.8	82.8	59.9	79.3	
1922/23	42.7	62.7	116.3	161.6	165.6	36.8	77.5	54.6	34.8	148.1	152.9	216.2	1269.8
1923/24	192.0	103.1	105.7	104.7	68.6	34.3	95.3	129.8	99.6	123.7	122.7	145.0	1324.4
1924/25	107.4	85.3	219.0	135.4	119.9	74.4	127.3	202.7	45.7	47.5	113.3	82.0	1360.0
1925/26	122.4	35.6	113.5	170.7	142.8	95.5	64.8	93.0	78.2	69.9	136.4	103.4	1226.1
1926/27	170.7	203.7	70.9	171.5	111.0	143.8	182.9	90.2	156.2	137.7	181.1	189.0	1808.6
1927/28	158.0	188.7	36.8	279.2	125.2	164.9	65.5	53.3	156.2	106.2	147.8	152.2	1634.0
1928/29	239.5	181.4	131.3	36.8	68.1	36.1	34.5	101.6	74.4	109.7	184.2	71.4	1269.0
1929/30	125.7	195.6	280.2	181.6	23.9	60.5	68.6	70.9	56.4	102.9	178.8	144.8	1489.8
1930/31	182.9	149.9	149.1	131.8	174.8	40.6	46.5	102.1	192.5	132.6	60.7	35.1	1398.6
1931/32	72.9	203.5	110.0	261.4	1.3	83.8	106.4	121.2	29.5	90.4	70.1	111.0	1261.4
1932/33	245.6	87.9	218.7	115.3	138.7	109.0	79.8	109.0	49.8	102.1	92.2	17.8	1365.8
1933/34	70.6	111.0	37.1	232.2	38.4	87.6	133.1	166.9	82.8	85.1	128.0	170.9	1343.7
1934/35	222.8	63.2	201.2	80.3	224.5	62.5	110.7	13.5	116.1	58.9	55.9	159.3	1368.9
1935/36	321.6	159.8	96.0	126.2	81.5	118.6	46.7	51.8	52.8	159.5	65.5	104.4	1384.6
1936/37	186.2	127.8	248.2	214.1	181.4	78.0	56.9	58.9	114.3	109.0	67.3	176.0	1618.0
1937/38	92.0	41.4	73.2	205.0	89.4	181.4	29.7	115.6	212.4	125.2	62.5	188.2	1415.9
1938/39	317.8	236.2	94.0	83.8	159.0	127.0	99.1	55.1	58.2	141.5	59.9	52.1	1483.7
1939/40	69.6	234.7	94.0	49.8	70.4	97.5	182.1	38.1	25.7	99.1	56.9	98.8	1116.6
1940/41	218.2	222.0	162.1	6.9	102.6	99.8	73.9	73.7	30.0	109.7	144.8	58.7	1302.3
1941/42	165.1	131.1	84.8	113.8	79.5	111.8	83.6	94.7	67.3	117.9	145.8	149.6	1345.0
1942/43	211.1	35.3	191.3	138.2	131.6	78.0	118.9	108.0	124.5	81.3	223.8	115.1	1556.8
1943/44	248.9	85.3	80.3	199.1	58.4	39.1	74.7	95.8	131.6	86.9	88.1	127.0	1315.3
1944/45	138.9	194.6	152.7	85.1	207.0	106.9	61.5	111.3	114.8	127.0	55.1	161.3	1516.2
1945/46	144.8	17.3	123.2	176.5	106.2	79.3	54.1	60.2	83.3	115.3	94.5	224.0	1278.7
1946/47	15.0	192.5	183.4	177.0	25.7	100.3	157.0	135.9	116.8	121.9	0.0	144.8	1370.4
1947/48	73.9	214.4	87.4	213.6	163.1	131.8	87.9	53.1	133.9	116.6	234.2	227.1	1736.9
1948/49	278.6	117.1	184.4	165.4	154.9	96.3	162.8	65.5	32.8	83.3	92.2	62.2	1495.6
1949/50	194.8	132.3	244.1	127.3	156.2	95.8	112.0	50.0	86.9	214.4	146.8	283.7	1844.4

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1950/51	165.6	103.9	49.0	163.8	98.8	99.6	86.4	61.2	82.6	90.2	145.3	122.2	1268.5
1951/52	54.9	182.6	257.3	137.4	67.3	115.3	77.7	46.5	108.0	82.8	113.8	94.7	1338.4
1952/53	169.7	70.4	192.0	101.9	77.2	74.2	81.5	79.8	40.4	183.6	112.0	145.3	1328.0
1953/54	103.1	240.0	169.4	182.1	121.9	108.0	92.5	119.1	113.3	107.7	180.3	214.9	1752.4
1954/55	251.7	245.4	239.5	90.9	79.8	56.9	115.8	132.3	120.7	47.5	44.2	150.6	1575.4
1955/56	166.6	85.1	220.2	142.0	41.9	91.7	48.8	95.5	90.9	133.4	165.6	168.9	1450.7
1956/57	144.5	72.6	194.3	192.5	101.6	160.0	63.8	78.7	64.5	143.3	132.1	99.3	1447.3
1957/58	170.9	56.6	166.1	174.8	108.2	56.9	65.5	134.6	98.8	176.3	156.0	124.5	1489.3
1958/59	167.6	66.0	181.1	69.1	64.3	109.5	109.0	32.0	95.5	196.6	48.8	53.6	1193.1
1959/60	137.4	151.1	213.6	105.7	125.5	69.3	124.5	65.0	96.0	127.5	96.3	87.1	1399.1
1960/61	69.9	152.7	163.6	168.9	153.9	81.0	140.7	70.1	64.3	100.6	206.0	189.2	1560.8
1961/62	201.2	147.1	124.0	252.0	120.4	42.9	67.8	63.5	72.1	97.0	189.0	206.8	1583.8
1962/63	59.2	90.4	149.6	19.6	30.5	170.9	77.0	127.3	84.6	68.1	108.2	*97.1*	*1082.5*
1963/64	148.1	162.6	62.0	76.6	36.4	72.3	122.0	118.2	79.5	84.3	147.1	147.5	1256.6
1964/65	92.4	154.8	159.8	174.8	33.3	93.2	114.0	102.6	124.0	119.6	139.4	176.3	1484.2
1965/66	199.4	65.3	186.9	87.1	166.9	131.3	104.4	111.0	138.7	58.4	80.0	134.9	1464.3
1966/67	106.2	115.8	204.2	122.4	160.5	145.0	69.6	143.3	71.6	112.0	74.2	121.7	1446.5
1967/68	249.9	95.0	88.4	136.9	80.8	129.8	75.4	120.1	51.8	88.6	104.9	144.5	1366.1
1968/69	224.8	98.8	64.8	146.4	47.5	27.7	61.9	140.0	98.4	72.3	69.3	95.2	1147.1
1969/70	112.9	201.8	108.7	110.1	128.3	76.8	121.3	63.4	87.1	123.5	91.0	146.6	1371.5
1970/71	213.5	226.0	99.0	134.3	113.4	56.1	55.5	73.5	58.5	72.8	118.7	55.4	1276.7
1971/72	174.5	105.0	105.6	149.0	91.4	72.7	117.6	103.9	109.4	64.4	64.0	12.1	1169.6
1972/73	40.3	143.3	127.2	141.4	122.1	73.6	63.0	105.1	85.3	58.8	109.2	124.3	1193.6
1973/74	98.9	151.2	203.0	302.0	129.4	79.6	6.9	81.0	72.9	109.9	90.1	149.2	1474.1
1974/75	46.1	162.8	258.0	242.7	53.6	33.5	74.2	24.8	66.5	98.1	65.1	187.4	1312.8
1975/76	112.4	129.8	44.9	199.0	106.3	140.2	54.4	186.1	70.7	57.0	11.8	114.9	1227.5
1976/77	149.4	149.0	84.3	74.3	129.6	125.8	117.2	61.7	51.9	59.4	*96.6*	195.7	*1294.9*
1977/78	177.5	187.8	107.8	161.3	90.4	191.2	35.2	14.9	99.3	52.1	115.2	214.7	1447.4
1978/79	84.4	218.8	128.4	109.4	26.3	147.0	80.4	54.6	47.7	73.4	154.1	113.8	1238.3
1979/80	188.9	225.3	196.7	100.3	112.2	112.5	6.8	25.5	119.3	146.2	158.4	207.6	1599.7
1980/81	165.7	166.9	245.2	126.5	97.4	179.1	15.7	108.0	102.7	96.8	22.5	261.2	1587.7
1981/82	203.9	227.2	41.5	134.9	112.6	158.6	38.4	78.0	71.7	24.8	163.4	218.3	1473.3
1982/83	157.3	207.1	224.0	234.1	33.9	155.8	60.7	77.7	66.8	38.3	40.7	190.7	*1487.1*
1983/84	282.5	41.0	151.6	244.2	116.3	58.0	48.4	17.7	46.8	*16.7*	46.1	137.1	*1206.4*
1984/85	224.9	174.6	160.8	58.9	43.8	77.2	*115.4*	68.5	61.5	223.0	*240.9*	*264.4*	*1713.9*
1985/86	57.0	124.9	*230.5*	189.7	3.6	193.1	80.0	200.5	61.7	76.4	135.4	56.7	*1409.5*
1986/87	197.0	262.8	291.3	82.7	106.3	172.6	50.2	65.3	103.8	60.4	130.0	129.5	1651.9
1987/88	149.4	97.3	162.9	199.9	136.6	185.8	81.2	72.7	20.9	163.5	173.3	155.4	1598.9
1988/89	199.8	99.5	150.9	139.7	194.6	178.8	66.0	37.2	93.3	37.9	171.9	89.6	1459.2
1989/90	172.7	56.2	115.0	293.8	277.0	225.0	105.0	45.0	120.0	75.0	110.0	100.0	1694.7
1990/91	225.0	65.0	185.0	160.0	80.0	140.0	160.0	10.0	143.3	85.8	65.3	136.3	1455.7
1991/92	174.1	200.3	165.0	155.0	190.0	211.0	95.0	92.0	30.0	100.0	257.9	193.9	1864.2
1992/93	85.0	222.8	135.3										
μ	157.8	141.1	150.7	149.4	105.4	105.3	84.8	86.2	86.0	101.6	115.0	139.1	1424.9
SD	68.9	63.2	63.7	62.6	54.1	48.7	37.9	42.3	38.3	41.8	55.8	58.6	176.0
CV	43.7	44.8	42.3	41.9	51.4	46.2	44.7	49.1	44.5	41.1	48.5	42.1	12.4
skew	0.1	0.0	0.1	0.2	0.4	0.4	0.5	0.6	0.8	0.7	0.4	0.1	0.5
min	15.0	17.3	36.8	6.9	1.3	24.4	6.8	10.0	20.9	16.7	0.0	12.1	1082.5
Q1	104.7	89.1	102.3	107.5	68.3	73.2	61.7	57.0	60.0	73.1	66.4	99.1	1296.8
Me	165.7	147.1	151.6	142.0	106.3	97.5	77.7	78.7	82.8	99.1	112.0	144.5	1404.3
Q2	200.5	195.1	195.5	181.9	134.1	140.1	111.4	111.1	111.3	123.6	150.4	181.9	1511.0
max	321.6	262.8	291.3	302.0	277.0	225.0	182.9	202.7	212.4	223.0	257.9	283.7	1864.2

Station XII (Helensburgh):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1870/71				84.0	213.0	93.0	142.0	28.0	60.0	123.0	93.0	49.0	
1871/72	152.0	117.0	150.0	191.0	170.0	135.0	53.0	66.0	208.0	171.0	144.0	212.0	1769.0
1872/73	122.0	155.0	198.0	198.0	37.0	38.0	10.0	74.0	76.0	103.0	130.0	113.0	1254.0
1873/74	185.0	109.0	112.0	150.0	36.0	119.0	49.0	50.0	26.0	81.0	150.0	185.0	1252.0
1874/75	226.0	165.0	71.0	211.0	46.0	79.0	55.0	91.0	84.0	40.0	127.0	104.0	1299.0
1875/76	191.0	149.0	160.0	140.0	147.0	168.0	71.0	23.0	86.0	89.0	149.0	132.0	1505.0
1876/77	140.0	89.0	175.0	211.0	168.0	86.0	150.0	50.0	97.0	163.0	191.0	52.0	1572.0
1877/78	185.0	187.0	196.0	160.0	53.0	95.0	89.0	140.0	72.0	21.0	117.0	135.0	1450.0
1878/79	189.0	48.0	51.0	33.0	71.0	142.0	60.0	79.0	138.0	114.0	149.0	196.0	1270.0
1879/80	91.0	46.0	91.0	123.0	113.0	89.0	79.0	48.0	55.0	79.0	64.0	54.0	932.0
1880/81	15.0	161.0	137.0	23.0	137.0	74.0	53.0	79.0	99.0	173.0	117.0	80.0	1148.0
1881/82	79.0	201.0	155.0	132.0	126.0	160.0	71.0	68.0	148.0	179.0	83.0	125.0	1527.0
1882/83	123.0	194.0	174.0	201.0	162.0	69.0	89.0	66.0	71.0	85.0	130.0	84.0	1448.0
1883/84	153.0	191.0	217.0	242.0	173.0	104.0	43.0	113.0	46.0	162.0	84.0	86.0	1614.0
1884/85	155.0	192.0	224.0	122.0	161.0	53.0	71.0	108.0	25.0	51.0	101.0	214.0	1477.0
1885/86	131.0	93.0	107.0	201.0	76.0	104.0	61.0	91.0	37.0	81.0	87.0	179.0	1248.0

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1886/87	121.0	146.0	127.0	121.0	133.0	66.0	78.0	23.0	30.0	97.0	93.0	125.0	1160.0
1887/88	32.0	86.0	138.0	122.0	46.0	94.0	61.0	117.0	94.0	145.0	114.0	48.0	1097.0
1888/89	53.0	163.0	135.0	135.0	88.0	73.0	83.0	88.0	35.0	57.0	209.0	50.0	1169.0
1889/90	102.0	64.0	110.0	220.0	30.0	102.0	37.0	53.0	129.0	96.0	91.0	208.0	1242.0
1890/91	95.0	211.0	30.0	99.0	38.0	92.0	48.0	53.0	37.0	28.0	139.0	205.0	1075.0
1891/92	112.0	116.0	211.0	109.0	59.0	34.0	31.0	122.0	107.0	74.0	234.0	151.0	1360.0
1892/93	97.0	118.0	71.0	53.0	122.0	51.0	44.0	70.0	51.0	92.0	124.0	94.0	987.0
1893/94	160.0	89.0	146.0	157.0	245.0	91.0	39.0	56.0	74.0	90.0	116.0	5.0	1268.0
1894/95	81.0	93.0	105.0	46.0	12.0	74.0	59.0	7.0	64.0	105.0	188.0	48.0	882.0
1895/96	84.0	167.0	122.0	79.0	58.0	118.0	52.0	17.0	83.0	121.0	53.0	107.0	1061.0
1896/97	61.0	41.0	139.0	36.0	65.0	125.0	40.0	60.0	165.0	56.0	150.0	104.0	1042.0
1897/98	68.0	69.0	120.0	94.0	87.0	39.0	96.0	46.0	77.0	36.0	152.0	170.0	1054.0
1898/99	89.0	133.0	187.0	192.0	76.0	117.0	96.0	81.0	50.0	78.0	27.0	122.0	1248.0
1899/1900	101.0	99.0	123.0										
1900/01				69.0	42.0	46.0	62.0	46.0	91.0	58.0	107.0	64.0	
1901/02	119.0	89.0	117.0	81.0	57.0	71.0	36.0	67.0	44.0	93.0	78.0	102.0	954.0
1902/03	50.0	105.0	130.0	165.0	141.0	157.0	30.0	71.0	73.0	107.0	194.0	97.0	1320.0
1903/04	254.0	75.0	96.0	94.0	119.0	53.0	29.0	91.0	64.0	50.0	116.0	107.0	1148.0
1904/05	54.0	73.0	132.0	76.0	75.0	100.0	73.0	56.0	22.0	76.0	125.0	57.0	919.0
1905/06	110.0	117.0	99.0	145.0	81.0	92.0	31.0	136.0	36.0	67.0	98.0	57.0	1069.0
1906/07	163.0	115.0	109.0	89.0	87.0	131.0	56.0	107.0	124.0	71.0	153.0	49.0	1254.0
1907/08	127.0	86.0	156.0	143.0	68.0	120.0	34.0	62.0	62.0	107.0	105.0	163.0	1233.0
1908/09	30.0	74.0	105.0	*139.8*	*76.3*	*31.6*	*117.3*	*87.6*	*63.5*	*97.5*	*101.0*	*58.0*	*981.7*
1909/10	*203.9*	*95.0*	*153.0*	*194.0*	*156.9*	*96.2*	*120.2*	*60.5*	*42.9*	*143.7*	*242.1*	47.0	*1555.5*
1910/11	66.0	111.0	154.0	125.0	221.0	55.0	103.0	78.0	88.0	104.0	114.0	71.0	1290.0
1911/12	120.0	186.0	227.0	161.0	138.0	170.0	76.0	61.0	137.0	66.0	136.0	108.0	1586.0
1912/13	173.0	147.0	326.0	139.0	122.0	167.0	112.0	120.0	86.0	51.0	58.0	66.0	1567.0
1913/14	63.0	182.0	122.0	113.0	145.0	164.0	81.0	66.0	25.0	73.0	161.0	72.0	1267.0
1914/15	68.0	191.0	259.0	118.0	204.0	97.0	88.0	25.0	51.0	85.0	67.0	48.0	1301.0
1915/16	83.0	71.0	145.0	178.0	159.0	53.0	103.0	124.0	46.0	70.0	97.0	36.0	1165.0
1916/17	224.0	163.0	169.0	82.0	38.0	89.0	48.0	103.0	114.0	51.0	139.0	93.0	1313.0
1917/18	219.0	252.0	101.0	181.0	187.0	56.0	21.0	88.0	43.0	101.0	107.0	140.0	1496.0
1918/19	174.0	194.0	167.0	117.0	53.0	115.0	79.0	29.0	97.0	44.0	96.0	97.0	1262.0
1919/20	22.0	117.0	217.0	215.0	211.0	132.0	57.0	155.0	62.0	105.0	159.0	99.0	1551.0
1920/21	83.0	158.0	117.0	255.0	49.0	175.0	38.0	89.0	18.0	144.0	198.0	78.0	1402.0
1921/22	131.0	124.0	256.0	174.0	138.0	68.0	89.0	133.0	68.0	117.0	70.0	76.0	1444.0
1922/23	68.0	120.0	129.0	170.0	161.0	61.0	123.0	58.0	36.0	102.0	194.0	215.0	1437.0
1923/24	197.0	132.0	134.0	161.0	40.0	42.0	70.0	127.0	85.0	132.0	108.0	152.0	1380.0
1924/25	109.0	124.0	203.0	146.0	112.0	78.0	163.0	188.0	31.0	59.0	110.0	111.0	1434.0
1925/26	118.0	28.0	115.0	179.0	179.0	133.0	63.0	87.0	100.0	74.0	123.0	99.0	1298.0
1926/27	193.0	190.0	92.0	178.0	121.0	128.0	92.0	86.0	141.0	119.0	151.0	205.0	1696.0
1927/28	191.0	156.0	55.0	324.0	148.0	132.0	66.0	52.0	159.0	105.0	120.0	124.0	1632.0
1928/29	215.0	235.0	154.0	63.0	72.0	44.0	37.0	91.0	88.0	125.0	171.0	45.0	1340.0
1929/30	188.0	191.0	333.0	160.0	8.0	81.0	55.0	65.0	96.0	81.0	161.0	113.0	1532.0
1930/31	204.0	173.0	130.0	147.0	130.0	37.0	62.0	121.0	157.0	80.0	52.0	31.0	1324.0
1931/32	107.0	178.0	137.0	216.0	5.0	63.0	108.0	80.0	32.0	83.0	69.0	113.0	1191.0
1932/33	182.0	146.0	233.0	170.0	140.0	67.0	68.0	94.0	59.0	105.0	106.0	18.0	1388.0
1933/34	68.0	85.0	28.0	193.0	29.0	85.0	87.0	105.0	83.0	63.0	122.0	155.0	1103.0
1934/35	248.0	72.0	227.0	78.0	189.0	58.0	104.0	18.0	92.0	63.0	92.0	200.0	1441.0
1935/36	313.0	138.0	123.0	148.0	84.0	84.0	39.0	52.0	47.0	137.0	102.0	95.0	1362.0
1936/37	184.0	130.0	234.0	229.0	172.0	60.0	69.0	40.0	109.0	101.0	107.0	84.0	1519.0
1937/38	81.0	29.0	87.0	208.0	96.0	140.0	22.0	113.0	160.0	124.0	62.0	127.0	1249.0
1938/39	262.0	258.0	164.0	107.0	169.0	121.0	75.0	46.0	75.0	140.0	48.0	122.0	1587.0
1939/40	81.0	228.0	100.0	74.0	78.0	119.0	84.0	27.0	18.0	96.0	68.0	94.0	1067.0
1940/41	173.0	180.0	171.0	34.0	134.0	83.0	65.0	88.0	31.0	91.0	146.0	47.0	1243.0
1941/42	156.0	134.0	96.0	189.0	41.0	135.0	58.0	83.0	74.0	91.0	148.0	152.0	1357.0
1942/43	202.0	34.0	194.0	135.0	155.0	101.0	111.0	115.0	89.0	86.0	242.0	98.0	1562.0
1943/44	255.0	81.0	82.0	203.0	65.0	39.0	92.0	103.0	107.0	132.0	98.0	127.0	1384.0
1944/45	133.0	209.0	150.0	110.0	216.0	104.0	67.0	125.0	118.0	197.0	68.0	162.0	1659.0
1945/46	169.0	21.0	150.0	189.0	108.0	86.0	56.0	55.0	106.0	103.0	102.0	175.0	1320.0
1946/47	15.0	177.0	162.0	155.0	41.0	120.0	173.0	141.0	113.0	133.0	1.0	140.0	1371.0
1947/48	73.0	227.0	81.0	225.0	148.0	126.0	83.0	51.0	124.0	125.0	199.0	192.0	1654.0
1948/49	284.0	117.0	185.0	168.0	141.0	75.0	161.0	65.0	27.0	102.0	122.0	49.0	1496.0
1949/50	206.0	146.0	258.0	128.0	147.0	87.0	84.0	39.0	78.0	179.0	158.0	275.0	1785.0
1950/51	185.0	87.0	76.0	163.0	87.0	91.0	73.0	59.0	51.0	93.0	100.0	110.0	1175.0
1951/52	49.0	193.0	244.0	142.0	57.0	106.0	71.0	43.0	84.0	71.0	127.0	90.0	1277.0
1952/53	148.0	90.0	178.0	75.0	66.0	48.0	65.0	87.0	38.0	152.0	120.0	146.0	1213.0
1953/54	101.0	230.0	145.0	197.0	140.0	86.0	81.0	119.0	85.0	106.0	138.0	205.0	1633.0
1954/55	263.0	173.0	223.0	82.0	85.0	54.0	93.0	88.0	96.0	37.0	29.0	128.0	1351.0
1955/56	127.0	70.0	213.0	115.0	48.0	81.0	52.0	77.0	68.0	136.0	147.0	132.0	1266.0
1956/57	113.0	70.0	190.0	198.0	109.0	169.0	70.0	73.0	65.0	172.0	114.0	80.0	1423.0
1957/58	142.0	54.0	148.0	136.0	90.0	34.0	52.0	116.0	89.0	140.0	158.0	119.0	1278.0
1958/59	135.0	59.0	144.0	65.0	53.0	82.0	99.0	36.0	66.0	180.0	42.0	47.0	1008.0
1959/60	120.0	137.0	217.0	122.0	110.0	79.0	126.0	72.0	90.0	125.0	80.0	82.0	1360.0
1960/61	116.0	154.0	130.0	138.7	157.0	80.5	125.0	66.5	57.7	108.5	192.0	164.3	1490.2

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1961/62	201.7	127.8	135.6	237.0	134.1	45.5	81.0	65.3	71.4	85.9	182.6	195.6	1563.5
1962/63	58.7	78.2	147.6	12.4	61.2	164.6	74.4	121.2	85.9	78.7	102.9	85.9	1071.7
1963/64	147.1	162.3	51.1	58.3	32.3	67.7	129.4	121.6	78.1	95.8	143.8	137.6	1225.1
1964/65	101.2	145.1	152.2	168.9	25.7	94.7	101.6	108.2	149.9	105.9	125.2	192.8	1471.4
1965/66	167.4	58.4	180.8	89.4	157.5	133.4	77.5	106.2	133.4	46.2	114.3	143.0	1407.5
1966/67	108.5	133.4	222.8	123.2	132.3	124.0	43.7	91.7	54.4	101.1	63.5	135.6	1334.2
1967/68	265.9	91.7	86.9	120.1	66.5	118.9	85.6	101.6	52.6	90.2	98.3	173.0	1351.3
1968/69	162.1	95.0	52.8	114.9	37.7	24.6	55.8	115.8	85.8	72.4	72.4	95.3	984.6
1969/70	*77.2*	*176.5*	*117.2*	*121.4*	*135.2*	*59.0*	*97.1*	*34.1*	*74.8*	*99.4*	*96.3*	*142.8*	*1231.0*
1970/71	226.5	231.3	103.0	135.6	102.5	64.5	70.5	81.5	63.9	82.8	100.2	58.6	1320.9
1971/72	206.9	103.0	105.6	*138.3*	*80.0*	*65.8*	*115.0*	*133.5*	*120.8*	*64.7*	*51.1*	*12.0*	*1196.8*
1972/73	*36.7*	*145.5*	*150.8*	*125.6*	*92.9*	*62.4*	*67.8*	*103.5*	*88.6*	*88.1*	*92.8*	*86.5*	*1141.1*
1973/74	*64.4*	*131.1*	*170.3*	*273.3*	*104.4*	*78.0*	*9.5*	*64.0*	*50.2*	*93.0*	*94.9*	*129.2*	*1262.4*
1974/75	*39.6*	*161.3*	*228.4*	*271.7*	*70.8*	*35.4*	*72.1*	*21.7*	*72.2*	*70.9*	*54.7*	*197.1*	*1296.2*
1975/76	*114.5*	*141.4*	*49.8*	*165.6*	*96.9*	*143.0*	*56.7*	*167.0*	*57.4*	*63.7*	*18.3*	*89.4*	*1163.7*
1976/77	*160.3*	*146.4*	*98.5*	*88.9*	*153.5*	*154.3*	*87.4*	*52.8*	*43.8*	*59.6*	*100.6*	*157.4*	*1303.7*
1977/78	*186.5*	*172.6*	*100.1*	*153.9*	99.8	182.1	28.6	9.3	74.2	*72.8*	129.7	216.1	*1425.6*
1978/79	89.8	236.3	152.1	125.5	34.0	169.6	80.8	52.3	41.9	80.2	151.8	156.7	1371.0
1979/80	190.0	243.7	215.4	119.2	*101.9*	*102.1*	*7.1*	*21.8*	*106.1*	*124.8*	*152.2*	*154.7*	*1539.1*
1980/81	*140.5*	*165.1*	*233.2*	136.0	107.2	184.1	15.2	96.8	98.6	90.1	32.2	257.6	*1556.5*
1981/82	213.4	224.6	54.7	128.7	108.7	148.5	35.4	96.4	88.6	28.4	153.3	229.8	1510.5
1982/83	173.7	230.6	212.1	244.6	48.3	159.1	60.1	91.1	66.3	30.9	34.5	216.6	1567.9
1983/84	287.1	39.5	177.6	255.8	130.5	47.6	43.9	19.0	64.2	10.2	61.3	163.5	1300.2
1984/85	227.6	218.1	223.4	81.1	40.4	82.9	93.6	59.0	66.3	213.6	223.2	249.3	1778.5
1985/86	65.2	155.0	224.2	207.4	5.2	197.4	86.8	196.8	67.3	75.6	128.5	56.7	1466.1
1986/87	175.5	294.7	303.5	88.6	127.9	191.7	49.4	70.3	95.0	87.2	161.5	153.5	1798.8
1987/88	164.9	101.1	166.3	193.9	138.5	198.1	76.6	77.1	39.1	207.1	168.2	167.8	1698.7
1988/89	200.0	125.9	153.2	174.7	205.5	208.3	63.5	45.1	73.3	48.8	176.4	126.7	1601.4
1989/90	192.4	52.1	103.0	268.0	295.6	257.6	105.9	53.4	114.1	83.8	123.2	119.7	1768.8
1990/91	240.2	58.9	194.3	160.6	73.2	157.0	151.5	15.4	139.3	108.8	64.6	115.1	1478.9
1991/92	216.7	209.0	165.0	157.6	189.1	210.5	93.6	95.0	36.1	102.1	273.0	203.8	1951.5
1992/93	92.1	226.0	125.6										
μ	141.3	136.8	151.3	145.5	106.1	101.3	73.2	78.2	78.2	96.5	118.8	121.2	1352.2
SD	66.5	59.0	59.5	58.8	56.9	46.8	32.8	37.1	36.2	39.5	50.0	57.5	213.4
CV	47.0	43.2	39.3	40.4	53.6	46.2	44.8	47.5	46.4	41.0	42.1	47.4	15.8
skew	0.2	0.2	0.5	0.2	0.5	0.7	0.6	0.5	0.8	0.6	0.4	0.3	0.2
min	15.0	21.0	28.0	12.4	5.0	24.6	7.1	7.0	18.0	10.2	1.0	5.0	882.0
Q1	89.0	89.0	109.0	110.0	59.0	66.0	52.0	52.8	51.0	72.4	92.0	80.0	1232.0
Me	135.0	134.0	147.6	140.0	102.5	92.0	71.0	77.0	74.0	92.0	116.0	115.1	1334.2
Q2	190.0	178.0	190.0	189.0	145.0	132.0	89.0	103.0	96.0	117.0	150.0	157.4	1500.5
max	313.0	294.7	333.0	324.0	295.6	257.6	173.0	196.8	208.0	213.6	273.0	275.0	1951.5

Station XIII (Glasgow Airport):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1919/20										82	129	59	
1920/21	38	111	106	166	31	143	19	51	10	101	144	43	963
1921/22	115	81	137	103	106	40	68	83	37	62	62	45	939
1922/23	51	64	94	100	109	37	93	38	25	83	124	153	971
1923/24	123	76	81	117	15	21	55	101	41	76	79	110	895
1924/25	79	72	170	122	78	56	125	156	10	45	94	75	1082
1925/26	93	18	90	148	113	74	68	74	45	73	77	71	944
1926/27	162	167	36	141	65	79	59	68	105	80	135	155	1252
1927/28	136	100	35	241	115	92	30	54	129	57	98	73	1160
1928/29	170	133	114	42	55	20	24	61	65	67	149	28	928
1929/30	141	161	230	141	6	79	30	41	69	113	123	91	1225
1930/31	152	126	105	97	84	29	36	109	117	109	53	29	1046
1931/32	73	181	99	162	1	52	93	76	29	78	28	100	972
1932/33	149	93	206	124	87	59	51	67	59	72	53	16	1036
1933/34	62	57	15	143	13	65	77	61	48	59	97	127	824
1934/35	145	25	139	50	112	40	76	13	103	35	42	157	937
1935/36	211	105	81	116	46	67	31	47	39	136	52	91	1022
1936/37	129	110	165	109	121	37	46	37	45	85	86	67	1037
1937/38	83	14	64	175	68	76	18	81	124	93	63	77	936
1938/39	209	205	75	114	142	71	53	34	46	114	37	43	1143
1939/40	63	204	65	64	38	95	57	26	20	92	49	87	860
1940/41	143	148	130	22	86	77	39	86	16	70	101	38	956
1941/42	95	85	64	162	48	69	60	69	42	55	112	125	986
1942/43	123	17	158	118	144	64	84	83	72	70	153	66	1152
1943/44	201	55	52	117	43	22	69	81	80	79	64	114	977
1944/45	125	179	109	85	154	79	62	127	94	98	40	126	1278
1945/46	136	8	81	144	69	55	34	29	70	86	66	168	946
1946/47	20	141	102	109	43	103	159	105	73	91	0	133	1079

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1947/48	55	153	52	158	123	99	79	42	123	72	150	141	1247
1948/49	109	83	157	118	117	36	109	59	23	47	111	60	1029
1949/50	160	112	201	75	109	57	71	28	42	144	125	208	1332
1950/51	91	76	36	126	72	70	57	48	56	81	115	73	901
1951/52	20	159	158	127	32	66	46	59	59	53	78	77	934
1952/53	111	48	95	30	37	25	36	49	62	103	79	98	773
1953/54	63	149	121	131	104	59	37	82	65	67	129	119	1126
1954/55	223	165	122	69	71	46	38	69	45	31	21	88	988
1955/56	66	50	159	64	28	53	22	48	61	104	117	118	890
1956/57	73	34	116	147	74	90	50	64	47	74	90	59	918
1957/58	93	35	103	115	60	23	27	74	73	121	92	81	897
1958/59	84	43	117	32	34	42	71	28	72	109	11	25	668
1959/60	115	116	172	87	92	51	86	70	45	85	84	68	1071
1960/61	78	125	118	83	94	51	85	43	33	61	125	136	1032
1961/62	135	102	107	169	68	29	58	54	39	69	126	163	1119
1962/63	40	62	109	18	11	116	50	76	56	70	77	69	754
1963/64	109	165	34	45	26	49	62	74	81	45	131	116	937
1964/65	58	77	125	109	15	55	61	79	75	87	104	129	974
1965/66	106	40	116	56	105	75	68	77	113	29	98	104	987
1966/67	75	84	160	85	107	120	39	108	37	75	57	95	1042
1967/68	223	73	52	82	51	99	47	121	27	72	57	137	1041
1968/69	151	85	40	96	32	17	39	105	67	55	62	66	815
1969/70	53	140	91	96	98	43	75	23	54	58	83	121	935
1970/71	138	150	63	88	100	33	37	49	31	84	100	27	900
1971/72	128	70	77	91	48	45	89	103	92	41	40	11	835
1972/73	31	112	105	107	58	42	62	75	59	66	59	65	841
1973/74	43	101	124	179	63	46	5	46	36	68	65	106	882
1974/75	30	125	156	200	49	25	52	16	65	54	43	163	978
1975/76	94	111	39	118	66	100	47	121	35	40	12	66	849
1976/77	117	116	75	70	113	107	67	40	34	45	78	136	998
1977/78	164	131	59	112	82	153	25	8	73	65	102	145	1119
1978/79	42	174	93	87	13	138	61	40	80	42	129	70	969
1979/80	131	189	152	70	75	72	7	23	75	94	129	111	1128
1980/81	123	128	168	86	79	136	11	138	71	91	14	227	1272
1981/82	147	142	31	106	82	129	31	74	68	13	97	144	1064
1982/83	137	169	132	196	39	93	37	87	53	21	30	150	1144
1983/84	210	17	121	157	95	49	14	16	36	11	24	121	871
1984/85	178	172	126	48	22	73	58	51	62	137	162	258	1347
1985/86	41	109	156	128	6	137	48	143	39	78	106	27	1018
1986/87	132	182	227	58	79	107	51	58	93	54	109	110	1260
1987/88	144	68	101	154	100	133	63	55	10	147	131	101	1207
1988/89	141	79	91	139	157	172	53	30	72	18	120	74	1146
1989/90	119	37	85	206	218	151	78	49	100	49	64	54	1210
1990/91	191	50	139	135	59	90	102	7	90	109	39	93	1104
1991/92	92	171	126	110	141	130	66	79	23	58	163	137	1296
1992/93	69	163	85										
μ	111.8	105.2	108.2	111.0	73.6	72.7	55.5	64.5	59.2	73.4	85.6	98.8	1019.4
SD	51.2	52.1	47.1	45.4	42.5	37.6	27.2	32.7	28.5	29.5	40.4	48.6	145.6
CV	45.8	49.6	43.6	40.9	57.8	51.8	49.1	50.6	48.1	40.1	47.2	49.2	14.3
skew	0.2	0.0	0.3	0.2	0.6	0.7	0.9	0.6	0.5	0.3	-0.1	0.6	0.3
min	20.0	8.0	15.0	18.0	1.0	17.0	5.0	7.0	10.0	11.0	0.0	11.0	668.0
Q1	73.0	68.0	77.0	84.5	42.0	44.5	37.0	41.8	38.5	55.0	57.0	66.0	932.5
Me	115.0	109.0	106.0	111.0	71.5	66.5	54.0	61.0	59.0	72.0	86.0	95.0	987.5
Q2	143.0	149.0	137.0	141.0	104.3	96.0	68.3	81.0	73.0	91.0	120.0	129.0	1120.8
max	223.0	205.0	230.0	241.0	218.0	172.0	159.0	156.0	129.0	147.0	163.0	258.0	1347.0

Station XIV (Stronachlachar):

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1914/15				177.8	373.4	135.9	161.3	36.8	53.3	118.1	87.6	68.6	
1915/16	132.1	85.1	246.4	397.5	250.2	76.2	151.1	149.9	82.6	87.6	104.1	47.0	1809.8
1916/17	351.8	265.4	247.7	88.9	44.5	104.1	63.5	108.0	102.9	57.2	260.4	152.4	1846.6
1917/18	335.3	396.2	113.0	213.4	369.6	68.6	36.8	92.7	90.2	118.1	139.7	231.1	2204.7
1918/19	327.7	294.6	264.2	175.3	41.9	154.9	148.6	47.0	111.8	47.0	127.0	186.7	1926.6
1919/20	63.5	188.0	383.5	350.5	406.4	246.4	95.3	256.5	88.9	133.4	170.2	124.5	2507.0
1920/21	142.2	279.4	213.4	420.4	81.3	414.0	53.3	152.4	27.9	157.5	193.0	101.6	2236.5
1921/22	210.8	127.0	434.3	259.1	236.2	83.8	119.4	188.0	81.3	149.9	114.3	116.8	2120.9
1922/23	91.4	170.2	254.0	302.3	307.3	114.3	162.6	86.4	61.0	198.1	221.0	332.7	2301.2
1923/24	348.0	190.5	157.5	221.0	55.9	22.9	129.5	170.2	91.4	203.2	144.8	226.1	1960.9
1924/25	147.3	193.0	360.7	241.3	185.4	91.4	210.8	279.4	34.3	71.1	172.7	104.1	2091.7
1925/26	228.6	55.9	198.1	459.7	188.0	233.7	95.3	118.1	129.5	104.1	193.0	139.7	2143.8
1926/27	237.5	326.4	147.3	315.0	132.1	157.5	162.6	133.4	177.8	133.4	185.4	172.7	2280.9
1927/28	259.1	217.2	43.2	576.6	309.9	325.1	132.1	35.6	182.9	176.5	229.9	156.2	2644.1

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1928/29	354.3	298.5	261.6	97.8	106.7	55.9	74.9	210.8	176.5	124.5	218.4	96.5	2076.5
1929/30	289.6	302.3	528.3	383.5	20.3	132.1	73.7	97.8	104.1	92.7	199.4	177.8	2401.6
1930/31	346.7	269.2	259.1	203.2	219.7	52.1	104.1	193.0	217.2	146.1	55.9	71.1	2137.4
1931/32	174.0	389.9	276.9	466.1	5.1	104.1	238.8	106.7	91.4	172.7	91.4	147.3	2264.4
1932/33	271.8	238.8	433.1	348.0	195.6	160.0	142.2	99.1	68.6	135.9	160.0	67.3	2320.3
1933/34	165.1	119.4	53.3	388.6	55.9	109.2	154.9	124.5	63.5	104.1	165.1	279.4	1783.1
1934/35	381.0	73.7	401.3	116.8	327.7	101.6	143.5	16.5	170.2	61.0	119.4	289.6	2202.2
1935/36	414.0	188.0	119.4	184.2	124.5	147.3	55.9	66.0	68.6	231.1	115.6	142.2	1856.7
1936/37	274.3	142.2	381.0	391.2	208.3	67.3	115.6	99.1	121.9	170.2	130.8	160.0	2261.9
1937/38	99.1	38.1	100.3	406.4	238.8	289.6	35.6	116.8	264.2	161.3	102.9	213.4	2066.3
1938/39	421.6	454.7	248.9	160.0	322.6	203.2	113.0	50.8	99.1	235.0	88.9	115.6	2513.3
1939/40	149.9	378.5	130.8	43.2	104.1	188.0	123.2	43.2	31.8	101.6	113.0	171.5	1578.6
1940/41	287.0	315.0	274.3	35.6	198.1	69.9	113.0	66.0	30.5	104.1	154.9	88.9	1737.4
1941/42	215.9	278.1	154.9	205.7	80.0	139.7	116.8	143.5	65.8	188.5	256.0	282.7	2127.8
1942/43	282.7	55.9	450.1	302.5	292.9	148.6	215.1	125.0	172.2	107.4	256.3	181.9	2590.5
1943/44	446.0	135.9	145.0	303.0	106.2	43.7	143.8	148.6	160.0	101.6	145.8	179.6	2059.2
1944/45	221.0	310.1	264.2	70.9	416.8	188.5	113.3	170.9	190.0	146.8	71.6	263.4	2427.5
1945/46	209.8	29.5	248.9	334.0	172.0	135.1	75.4	55.1	158.5	158.5	149.4	232.7	1958.8
1946/47	23.4	271.5	227.3	271.0	18.8	140.7	330.2	149.4	127.8	149.4	0.8	205.5	1915.7
1947/48	120.1	317.8	91.2	267.5	232.7	211.3	161.5	71.1	163.8	165.9	260.6	280.9	2344.4
1948/49	317.0	157.7	371.3	249.9	253.5	91.4	216.2	100.1	51.8	83.6	187.2	87.9	2167.6
1949/50	312.9	205.2	387.4	173.7	226.3	157.7	149.1	67.8	90.2	242.6	216.4	408.2	2637.5
1950/51	220.5	143.8	73.9	202.4	128.5	138.7	128.3	58.9	76.7	121.4	208.8	147.1	1649.0
1951/52	68.1	337.1	328.4	154.7	62.0	227.8	83.3	53.8	154.7	95.8	167.9	98.8	1832.4
1952/53	229.6	73.4	206.2	134.4	108.5	74.4	136.1	127.0	52.3	198.9	127.0	272.0	1739.9
1953/54	194.6	351.0	247.4	213.4	*169.9*	166.9	84.8	143.3	*119.6*	102.1	176.3	263.9	2233.2
1954/55	355.3	378.2	403.6	133.1	115.6	46.5	135.1	125.2	110.5	36.6	35.6	176.3	2051.6
1955/56	180.1	117.3	367.5	142.2	68.1	117.9	63.0	121.7	119.9	176.8	194.1	213.4	1881.9
1956/57	146.1	120.1	331.5	367.3	203.2	228.1	94.0	95.3	79.8	155.2	186.4	129.8	2136.6
1957/58	235.5	86.1	324.1	301.5	101.9	75.4	109.0	149.1	118.1	126.5	204.7	175.5	2007.4
1958/59	218.7	71.6	268.0	91.4	96.0	186.4	174.0	67.3	113.8	198.4	104.9	54.9	1645.4
1959/60	253.0	231.1	383.8	159.3	235.5	92.7	260.1	132.6	88.9	162.3	126.7	106.2	2232.2
1960/61	145.8	269.2	280.7	281.2	244.1	183.9	172.2	159.3	106.2	141.2	286.5	265.4	2535.7
1961/62	310.6	186.9	189.0	437.1	235.7	59.9	75.9	84.6	149.1	123.4	296.7	280.4	2429.5
1962/63	112.8	104.9	236.5	11.9	43.4	373.9	168.1	189.0	112.3	126.0	108.0	178.3	1765.0
1963/64	276.4	235.0	96.3	116.8	90.7	94.7	170.4	192.3	101.6	154.7	169.2	200.9	1898.9
1964/65	110.2	208.5	288.5	245.4	40.9	144.8	183.6	145.5	233.4	118.4	204.5	199.4	2123.2
1965/66	272.5	85.3	301.5	193.0	232.4	200.2	130.0	162.3	143.3	52.3	80.5	181.1	2034.5
1966/67	158.0	179.8	332.7	220.2	253.7	354.6	101.9	194.3	113.8	161.0	102.9	210.3	2383.3
1967/68	388.6	136.7	146.1	205.0	83.6	212.1	90.7	127.3	61.0	122.4	92.5	207.3	1873.0
1968/69	350.5	144.0	124.2	188.0	56.4	17.3	74.9	126.5	178.1	126.7	94.2	172.7	1653.5
1969/70	198.6	260.9	175.3	197.6	213.6	114.8	145.8	109.2	100.8	214.1	107.7	283.5	2121.9
1970/71	339.3	290.6	137.4	272.2	163.1	117.8	79.3	142.9	76.7	97.6	156.9	79.1	1952.9
1971/72	322.7	166.1	235.3	263.1	154.1	84.4	207.3	262.6	159.7	119.1	96.5	16.6	2087.5
1972/73	110.8	249.2	276.5	179.5	175.1	124.1	89.9	143.1	173.4	91.7	154.1	154.4	1921.8
1973/74	80.6	294.7	243.3	556.2	224.2	91.5	11.1	140.0	75.4	125.2	158.5	199.0	2199.7
1974/75	71.5	328.5	469.3	500.2	97.8	87.4	101.8	32.3	70.8	158.0	66.3	271.4	2255.3
1975/76	149.0	231.9	109.3	353.7	192.1	236.2	89.8	253.1	110.3	90.5	19.1	126.4	1961.4
1976/77	281.5	266.5	140.9	151.7	181.2	281.2	182.7	80.6	45.1	90.8	104.1	303.2	2109.5
1977/78	301.0	290.3	169.8	208.0	155.7	288.0	33.2	15.9	77.6	107.7	103.7	293.0	2043.9
1978/79	184.9	385.9	175.0	149.3	52.3	287.2	98.8	79.5	87.8	93.9	201.9	216.2	2012.7
1979/80	268.4	366.6	306.8	132.9	144.5	145.2	14.4	12.4	170.7	164.9	162.5	325.5	2214.8
1980/81	204.2	240.9	364.6	256.2	170.3	256.3	8.7	150.4	122.8	118.9	38.2	350.9	2282.4
1981/82	277.0	371.9	82.9	195.5	258.9	302.0	72.5	110.4	87.7	53.1	213.3	364.4	2389.6
1982/83	297.2	352.0	322.6	433.6	66.2	232.7	73.4	158.7	89.1	30.9	42.4	278.5	2377.3
1983/84	466.0	73.0	358.2	352.3	168.5	86.8	84.5	23.2	91.6	45.2	71.1	225.8	2046.2
1984/85	342.1	404.2	284.5	88.4	76.3	119.6	153.8	95.2	86.2	288.5	410.1	315.4	2664.3
1985/86	204.9	*151.2*	*392.0*	322.6	4.6	346.3	80.1	351.7	62.3	116.6	157.1	69.0	*2258.4*
1986/87	282.6	435.6	523.8	102.0	131.7	199.4	71.5	71.7	104.8	77.6	169.3	256.6	2426.6
1987/88	250.6	176.1	293.2	360.8	250.4	250.6	102.8	97.5	31.3	308.1	253.8	244.5	2619.7
1988/89	253.3	125.3	262.1	385.1	413.2	337.8	68.5	56.0	109.9	66.8	301.1	189.2	2568.3
1989/90	293.9	108.5	178.9	489.2	513.7	479.5	149.8	49.7	146.8	92.6	130.1	177.3	2810.0
1990/91	328.3	115.2	291.8	299.8	100.5	196.0	263.9	26.0	161.0	135.5	72.5	220.0	2210.5
1991/92	245.8	339.1	225.0	260.0	346.8	319.9	165.0	119.1	33.7	168.1	367.8	308.0	2898.3
1992/93	121.6	336.7	228.5										
μ	240.5	225.4	257.0	255.3	176.1	168.5	122.0	118.1	109.1	132.0	155.5	193.7	2156.4
SD	98.5	108.2	111.7	125.6	109.5	97.3	59.7	65.0	49.7	54.2	76.0	83.7	284.1
CV	41.0	48.0	43.5	49.2	62.2	57.8	48.9	55.0	45.6	41.1	48.9	43.2	13.2
skew	0.0	0.1	0.2	0.4	0.7	0.9	0.7	0.9	0.7	0.7	0.7	0.2	0.3
min	23.4	29.5	43.2	11.9	4.6	17.3	8.7	12.4	27.9	30.9	0.8	16.6	1578.6
Q1	159.8	136.1	171.1	163.4	92.0	91.8	79.5	68.6	76.7	96.2	103.8	132.3	1958.8
Me	248.2	231.5	256.5	243.3	170.1	145.0	114.4	117.5	102.2	124.8	154.5	184.3	2136.6
Q2	312.4	308.2	330.7	349.9	236.1	228.0	154.7	149.3	145.9	161.2	198.1	263.8	2320.3
max	466.0	454.7	528.3	576.6	513.7	479.5	330.2	351.7	264.2	308.1	410.1	408.2	2898.3

Appendix B

Seasonal and annual rainfall amounts and statistical calculations

In this appendix the seasonal Winter half-year (Oct–Mar), Summer half-year (Apr–Sep) and annual (Oct–Sep) rainfall amounts are presented for the selected rainfall stations. The 5-point running mean and the percentage of deviation from the mean are also presented for all the series.

The stations XII, XIII and XIV are located outside Loch Lomond basin and are used as control stations.

Station I (Allt Nan Caorrunn, Dubh Eas):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1947/48				1197.6		15.7			
1948/49	2328.3		31.9	971.0		-6.2	3299.2		17.9
1949/50	2213.2		25.3	1344.9		29.9	3558.1		27.2
1950/51	1420.4		-19.6	885.3		-14.5	2305.8		-17.6
1951/52	1648.5	1902.6	-6.6	851.6	1050.1	-17.7	2500.2	2915.8	-10.6
1952/53	1443.5	1810.8	-18.2	1076.5	1025.9	4.0	2520.0	2836.6	-9.9
1953/54	1898.2	1724.8	7.5	1079.2	1047.5	4.2	2977.4	2772.3	6.4
1954/55	1950.5	1672.2	10.5	709.7	920.5	-31.5	2660.2	2592.7	-4.9
1955/56	1517.7	1691.7	-14.0	973.6	938.1	-6.0	2491.3	2629.8	-10.9
1956/57	1922.9	1746.6	8.9	817.2	931.2	-21.1	2740.0	2677.8	-2.1
1957/58	1563.9	1770.7	-11.4	931.3	902.2	-10.1	2495.3	2672.9	-10.8
1958/59	1273.9	1645.8	-27.9	806.3	847.6	-22.1	2080.1	2493.4	-25.6
1959/60	1750.1	1605.7	-0.9	957.3	897.1	-7.5	2707.4	2502.8	-3.2
1960/61	2010.4	1704.2	13.9	1252.9	953.0	21.0	3263.3	2657.2	16.7
1961/62	2018.3	1723.3	14.3	1131.7	1015.9	9.3	3150.0	2739.2	12.6
1962/63	1258.5	1662.2	-28.7	1021.5	1033.9	-1.3	2280.0	2696.2	-18.5
1963/64	1347.2	1676.9	-23.7	1233.2	1119.3	19.1	2580.4	2796.2	-7.8
1964/65	1662.4	1659.4	-5.9	1166.4	1161.1	12.6	2828.8	2820.5	1.1
1965/66	1905.4	1638.4	7.9	892.2	1089.0	-13.8	2797.6	2727.4	0.0
1966/67	2294.9	1693.7	30.0	1095.8	1081.8	5.8	3390.7	2775.5	21.2
1967/68	1578.1	1757.6	-10.6	599.5	997.4	-42.1	2177.6	2755.0	-22.2
1968/69	1085.8	1705.3	-38.5	931.6	937.1	-10.0	2017.4	2642.4	-27.9
1969/70	1382.9	1649.4	-21.7	1296.8	963.2	25.2	2679.7	2612.6	-4.2
1970/71	1625.1	1593.4	-8.0	735.8	931.9	-28.9	2360.9	2525.3	-15.6
1971/72	1608.7	1456.1	-8.9	982.9	909.3	-5.1	2591.6	2365.4	-7.4
1972/73	1556.7	1451.8	-11.8	933.5	976.1	-9.8	2490.2	2428.0	-11.0
1973/74	1790.6	1592.8	1.4	943.0	978.4	-8.9	2733.6	2571.2	-2.3
1974/75	1870.0	1690.2	5.9	960.6	911.2	-7.2	2830.6	2601.4	1.2
1975/76	1651.7	1695.5	-6.5	852.0	934.4	-17.7	2503.7	2629.9	-10.5
1976/77	1563.9	1686.6	-11.4	1126.4	963.1	8.8	2690.3	2649.7	-3.8
1977/78	1583.4	1691.9	-10.3	908.5	958.1	-12.3	2491.9	2650.0	-10.9
1978/79	1588.9	1651.6	-10.0	1115.9	992.7	7.8	2704.8	2644.3	-3.3
1979/80	1649.9	1607.6	-6.6	1114.8	1023.5	7.7	2764.7	2631.1	-1.2
1980/81	1990.7	1675.4	12.7	1083.9	1069.9	4.7	3074.6	2745.3	9.9
1981/82	1767.1	1716.0	0.1	1185.3	1081.7	14.5	2952.4	2797.7	5.5
1982/83	2117.9	1822.9	19.9	855.3	1071.0	-17.4	2973.2	2893.9	6.3
1983/84	2022.4	1909.6	14.5	736.8	995.2	-28.8	2759.2	2904.8	-1.4
1984/85	1562.0	1892.0	-11.5	1718.4	1115.9	66.0	3280.4	3008.0	17.3
1985/86	1637.0	1821.3	-7.3	1141.0	1127.4	10.2	2778.0	2948.6	-0.7
1986/87	2133.1	1894.5	20.8	1029.6	1096.2	-0.6	3162.7	2990.7	13.1
1987/88	1885.3	1848.0	6.8	1246.3	1174.4	20.4	3131.6	3022.4	11.9
1988/89	2259.8	1895.4	28.0	997.7	1226.6	-3.6	3257.5	3122.0	16.4
1989/90	2313.1	2045.7	31.0	1041.0	1091.1	0.5	3354.1	3136.8	19.9
1990/91	1743.8	2067.0	-1.2	1198.0	1102.5	15.7	2941.8	3169.5	5.2
1991/92	2295.2	2099.4	30.0	1464.4	1189.5	41.4	3759.6	3288.9	34.4
1992/93									
μ	1765.7			1035.4			2797.5		
SD	312.1			207.1			392.6		
CV	17.7			20.0			14.0		
skew	0.1			0.7			0.3		
min	1085.8			599.5			2017.4		
Q1	1563.9			908.5			2502.8		
Me	1703.1			1021.5			2749.6		
Q2	1995.6			1141.0			3088.9		
max	2328.3			1718.4			3759.6		

Station II (Lairig, Arnan):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1947/48				1579.4		26.2			
1948/49	2348.6		20.0	1237.3		-1.2	3585.9		12.0
1949/50	2244.2		14.6	1529.1		22.1	3773.3		17.8
1950/51	1515.9		-22.6	1095.3		-12.5	2611.2		-18.5
1951/52	1643.2		-16.1	1172.3	1322.7	-6.4	2815.4		-12.1
1952/53	1467.2	1843.8	-25.1	1396.8	1286.2	11.6	2864.0	3130.0	-10.6
1953/54	1951.6	1764.4	-0.3	1399.6	1318.6	11.8	3351.2	3083.0	4.6
1954/55	2045.0	1724.6	4.5	929.7	1198.7	-25.7	2974.7	2923.3	-7.1
1955/56	1571.1	1735.6	-19.8	1316.8	1243.0	5.2	2887.8	2978.6	-9.8
1956/57	2213.2	1849.6	13.0	1131.9	1234.9	-9.6	3345.1	3084.5	4.5
1957/58	1656.1	1887.4	-15.4	1205.8	1196.7	-3.7	2861.9	3084.1	-10.6

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1958/59	1302.1	1757.5	-33.5	1142.3	1145.3	-8.8	2444.3	2902.8	-23.7
1959/60	1729.3	1694.3	-11.7	1214.9	1202.3	-2.9	2944.2	2896.7	-8.1
1960/61	2013.0	1782.7	2.8	1632.9	1265.6	30.4	3645.9	3048.3	13.9
1961/62	2038.9	1747.9	4.1	1452.8	1329.7	16.1	3491.7	3077.6	9.0
1962/63	1246.3	1665.9	-36.3	1218.8	1332.3	-2.6	2465.1	2998.2	-23.0
1963/64	1242.8	1654.1	-36.5	1523.5	1408.6	21.7	2766.3	3062.6	-13.6
1964/65	1564.1	1621.0	-20.1	1471.7	1459.9	17.6	3035.8	3081.0	-5.2
1965/66	1730.2	1564.5	-11.6	1110.1	1355.4	-11.3	2840.3	2919.8	-11.3
1966/67	2329.1	1622.5	19.0	1342.2	1333.3	7.2	3671.3	2955.8	14.6
1967/68	1981.5	1769.5	1.2	867.1	1262.9	-30.7	2848.6	3032.5	-11.0
1968/69	1127.3	1746.4	-42.4	1052.1	1168.6	-16.0	2179.4	2915.1	-31.9
1969/70	1708.4	1775.3	-12.7	1485.8	1171.5	18.7	3194.2	2946.8	-0.3
1970/71	1853.7	1800.0	-5.3	844.5	1118.3	-32.5	2698.2	2918.3	-15.7
1971/72	1959.1	1726.0	0.1	1288.7	1107.6	2.9	3247.8	2833.6	1.4
1972/73	1747.9	1679.3	-10.7	1226.5	1179.5	-2.0	2974.4	2858.8	-7.1
1973/74	2209.9	1895.8	12.9	1109.0	1190.9	-11.4	3318.9	3086.7	3.6
1974/75	2236.7	2001.5	14.2	1051.1	1104.0	-16.0	3287.8	3105.4	2.7
1975/76	2040.1	2038.7	4.2	1077.7	1150.6	-13.9	3117.8	3189.3	-2.6
1976/77	1628.5	1972.6	-16.8	1331.4	1159.1	6.4	2959.9	3131.8	-7.6
1977/78	1926.9	2008.4	-1.6	1036.2	1121.1	-17.2	2963.1	3129.5	-7.5
1978/79	1900.5	1946.5	-2.9	1291.2	1157.5	3.1	3191.7	3104.1	-0.3
1979/80	1748.9	1849.0	-10.7	1274.4	1202.2	1.8	3023.3	3051.2	-5.6
1980/81	2369.0	1914.8	21.0	1237.6	1234.2	-1.1	3606.6	3148.9	12.6
1981/82	2059.5	2001.0	5.2	1341.5	1236.2	7.2	3401.0	3237.1	6.2
1982/83	2588.0	2133.2	32.2	890.9	1207.1	-28.8	3478.9	3340.3	8.6
1983/84	2401.1	2233.3	22.6	840.5	1117.0	-32.9	3241.6	3350.3	1.2
1984/85	1742.7	2232.1	-11.0	1822.0	1226.5	45.5	3564.7	3458.6	11.3
1985/86	1983.4	2154.9	1.3	1237.3	1226.4	-1.2	3220.7	3381.4	0.6
1986/87	2443.9	2231.8	24.8	1141.5	1186.4	-8.8	3585.4	3418.3	12.0
1987/88	2193.9	2153.0	12.1	1433.6	1295.0	14.5	3627.5	3448.0	13.3
1988/89	2840.6	2240.9	45.1	1126.0	1352.1	-10.1	3966.6	3593.0	23.9
1989/90	2894.3	2471.2	47.8	1304.6	1248.6	4.2	4198.9	3719.8	31.1
1990/91	1940.6	2462.7	-0.9	1347.5	1270.6	7.6	3288.1	3733.3	2.7
1991/92	2768.7	2527.6	41.4	1571.7	1356.7	25.5	4340.4	3884.3	35.5
1992/93									
μ	1957.9			1251.9			3202.3		
SD	416.9			218.4			450.0		
CV	21.3			17.4			14.1		
skew	0.2			0.2			0.3		
min	1127.3			840.5			2179.4		
Q1	1695.3			1110.1			2881.9		
Me	1955.3			1237.3			3207.5		
Q2	2219.1			1396.8			3510.0		
max	2894.3			1822.0			4340.4		

Station III (Loch Sloy):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1945/46				1203.6		17.2			
1946/47	1220.0		-25.5	1322.1		28.8	2542.1		-4.5
1947/48	1714.6		4.7	1326.2		29.2	3040.8		14.3
1948/49	1967.8		20.1	923.1		-10.1	2890.9		8.6
1949/50	1879.4		14.7	1536.8		49.7	3416.2		28.4
1950/51	1284.8	1613.3	-21.6	968.8	1215.4	-5.6	2253.6	2828.7	-15.3
1951/52	1503.2	1670.0	-8.2	803.9	1111.8	-21.7	2307.2	2781.7	-13.3
1952/53	1174.0	1561.9	-28.3	1102.1	1066.9	7.3	2276.2	2628.8	-14.5
1953/54	1700.9	1508.5	3.8	1169.7	1116.3	13.9	2870.6	2624.7	7.9
1954/55	1858.6	1504.3	13.4	830.1	974.9	-19.1	2688.7	2479.2	1.0
1955/56	1320.1	1511.4	-19.4	1105.5	1002.3	7.7	2425.5	2513.6	-8.9
1956/57	1746.3	1560.0	6.6	928.9	1027.3	-9.5	2675.2	2587.2	0.5
1957/58	1448.1	1614.8	-11.6	1035.6	1014.0	0.9	2483.7	2628.7	-6.7
1958/59	1170.2	1508.7	-28.6	827.6	945.5	-19.4	1997.8	2454.2	-24.9
1959/60	1670.1	1471.0	1.9	952.0	969.9	-7.3	2622.1	2440.9	-1.5
1960/61	1699.5	1546.9	3.7	1371.4	1023.1	33.6	3070.9	2570.0	15.4
1961/62	1721.6	1541.9	5.1	1197.2	1076.8	16.6	2918.8	2618.7	9.7
1962/63	1075.4	1467.4	-34.4	1099.3	1089.5	7.1	2174.7	2556.9	-18.3
1963/64	1163.9	1466.1	-29.0	1300.4	1184.1	26.7	2464.3	2650.2	-7.4
1964/65	1343.0	1400.7	-18.0	1324.7	1258.6	29.0	2667.7	2659.3	0.2
1965/66	1597.4	1380.3	-2.5	921.9	1168.7	-10.2	2519.3	2549.0	-5.3
1966/67	1881.8	1412.3	14.9	1129.1	1155.1	10.0	3010.9	2567.4	13.1
1967/68	1500.9	1497.4	-8.4	731.5	1081.5	-28.8	2232.4	2578.9	-16.1
1968/69	1070.3	1478.7	-34.7	888.0	999.0	-13.5	1958.3	2477.7	-26.4
1969/70	1429.6	1496.0	-12.7	1151.2	964.3	12.1	2580.8	2460.3	-3.0

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1970/71	1616.2	1499.8	-1.4	659.0	911.8	-35.8	2275.2	2411.5	-14.5
1971/72	1501.7	1423.7	-8.3	1041.1	894.2	1.4	2542.8	2317.9	-4.4
1972/73	1443.5	1412.3	-11.9	918.9	931.6	-10.5	2362.4	2343.9	-11.2
1973/74	1859.3	1570.1	13.5	894.2	932.9	-12.9	2753.4	2502.9	3.5
1974/75	1839.7	1652.1	12.3	892.3	881.1	-13.1	2732.0	2533.2	2.7
1975/76	1488.9	1626.6	-9.1	769.4	903.2	-25.1	2258.3	2529.8	-15.1
1976/77	1361.7	1598.6	-16.9	962.5	887.5	-6.3	2324.2	2486.1	-12.7
1977/78	1601.6	1630.2	-2.2	814.7	866.6	-20.6	2416.3	2496.8	-9.2
1978/79	1560.0	1570.4	-4.8	903.2	868.4	-12.0	2463.2	2438.8	-7.4
1979/80	1611.3	1524.7	-1.7	1075.5	905.1	4.8	2686.8	2429.8	1.0
1980/81	1857.5	1598.4	13.4	919.1	935.0	-10.5	2776.6	2533.4	4.3
1981/82	1703.7	1666.8	4.0	1048.4	952.2	2.1	2752.1	2619.0	3.4
1982/83	2126.2	1771.7	29.8	711.0	931.4	-30.7	2837.2	2703.2	6.6
1983/84	1906.5	1841.0	16.4	650.5	880.9	-36.6	2557.0	2721.9	-3.9
1984/85	1575.1	1833.8	-3.9	1482.5	962.3	44.4	3057.6	2796.1	14.9
1985/86	1788.3	1820.0	9.2	961.9	970.9	-6.3	2750.2	2790.8	3.3
1986/87	1990.1	1877.2	21.5	882.6	937.7	-14.0	2872.7	2814.9	7.9
1987/88	1893.7	1830.7	15.6	1199.6	1035.4	16.8	3093.3	2866.2	16.2
1988/89	2306.3	1910.7	40.8	906.8	1086.7	-11.7	3213.1	2997.4	20.7
1989/90	2441.9	2084.1	49.0	917.3	973.6	-10.7	3359.2	3057.7	26.2
1990/91	1581.1	2042.6	-3.5	1125.0	1006.3	9.6	2706.1	3048.9	1.7
1991/92	2167.7	2078.1	32.3	1368.5	1103.4	33.3	3536.2	3181.6	32.9
1992/93									
µ	1638.3			1026.7			2661.2		
SD	313.4			214.5			358.8		
CV	19.1			20.9			13.5		
skew	0.3			0.5			0.4		
min	1070.3			650.5			1958.3		
Q1	1444.7			892.8			2418.6		
Me	1613.8			962.2			2671.5		
Q2	1858.3			1145.7			2872.2		
max	2441.9			1536.8			3536.2		

Station IV (Loch Arklet, Corriehichon):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1904/05				787.4		-11.8			
1905/06	1369.1		0.5	861.1		-3.5	2230.2		-1.1
1906/07	1257.3		-7.7	957.6		7.3	2215.0		-1.8
1907/08	1229.4		-9.8	1056.7		18.4	2286.1		1.3
1908/09	988.1		-27.5	828.1	898.2	-7.2	1816.2		-19.5
1909/10	1496.1	1268.0	9.8	1008.4	942.4	13.0	2504.5	2210.4	11.0
1910/11	1181.1	1230.4	-13.3	1005.9	971.3	12.7	2187.0	2201.8	-3.0
1911/12	1691.7	1317.3	24.2	871.3	954.1	-2.4	2563.0	2271.4	13.6
1912/13	1971.1	1465.6	44.7	693.4	881.4	-22.3	2664.6	2347.1	18.1
1913/14	1569.8	1582.0	15.2	790.0	873.8	-11.5	2359.8	2455.8	4.6
1914/15	1356.4	1554.0	-0.4	646.5	801.4	-27.6	2002.9	2355.4	-11.2
1915/16	1139.2	1545.7	-16.4	698.5	739.9	-21.7	1837.8	2285.6	-18.5
1916/17	1317.0	1470.7	-3.3	811.6	728.0	-9.1	2128.6	2198.7	-5.6
1917/18	1383.1	1353.1	1.5	718.8	733.1	-19.4	2101.9	2086.2	-6.8
1918/19	1214.2	1282.0	-10.9	815.4	738.2	-8.6	2029.5	2020.1	-10.0
1919/20	1595.2	1329.7	17.1	939.8	796.8	5.3	2535.0	2126.6	12.4
1920/21	1681.5	1438.2	23.4	758.2	808.8	-15.0	2439.8	2247.0	8.2
1921/22	1341.2	1443.0	-1.5	878.9	822.2	-1.5	2220.0	2265.3	-1.6
1922/23	1207.8	1408.0	-11.3	1162.1	910.9	30.2	2369.9	2318.9	5.1
1923/24	1026.2	1370.4	-24.7	1022.4	952.3	14.6	2048.6	2322.7	-9.2
1924/25	1209.1	1293.2	-11.2	828.1	929.9	-7.2	2037.2	2223.1	-9.7
1925/26	1320.9	1221.0	-3.0	864.9	951.3	-3.1	2185.8	2172.3	-3.1
1926/27	1412.3	1235.3	3.7	914.4	958.4	2.5	2326.7	2193.6	3.1
1927/28	1541.8	1302.1	13.2	998.3	925.6	11.9	2540.1	2227.7	12.6
1928/29	1198.9	1336.6	-12.0	942.4	909.6	5.6	2141.3	2246.2	-5.1
1929/30	1582.5	1411.3	16.2	800.1	904.0	-10.3	2382.6	2315.3	5.6
1930/31	1374.2	1421.9	0.9	778.5	886.7	-12.8	2152.7	2308.7	-4.6
1931/32	1447.9	1429.1	6.3	848.4	873.5	-4.9	2296.3	2302.6	1.8
1932/33	1531.7	1427.0	12.4	690.9	812.1	-22.6	2222.6	2239.1	-1.5
1933/34	866.2	1360.5	-36.4	962.7	816.1	7.9	1828.9	2176.6	-18.9
1934/35	1361.5	1316.3	-0.1	817.9	819.7	-8.3	2179.4	2136.0	-3.4
1935/36	1130.3	1267.5	-17.0	701.1	804.2	-21.4	1831.4	2071.7	-18.8
1936/37	1257.3	1229.4	-7.7	787.4	792.0	-11.8	2044.8	2021.4	-9.4
1937/38	1023.7	1127.8	-24.9	835.7	821.0	-6.3	1859.4	1948.8	-17.6
1938/39	1506.3	1255.8	10.6	635.0	755.4	-28.8	2141.3	2011.3	-5.1
1939/40	904.3	1164.4	-33.6	548.7	701.6	-38.5	1452.9	1866.0	-35.6
1940/41	1069.4	1152.2	-21.5	556.3	672.6	-37.7	1625.7	1824.8	-27.9

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1941/42	1026.2	1106.0	-24.7	1056.7	726.5	18.4	2082.9	1832.4	-7.7
1942/43	1242.1	1149.6	-8.8	1135.4	786.4	27.2	2377.5	1936.1	5.4
1943/44	1181.1	1084.6	-13.3	1028.7	865.2	15.3	2209.9	1949.8	-2.0
1944/45	1521.5	1208.1	11.7	1038.9	963.2	16.4	2560.4	2171.3	13.5
1945/46	1056.7	1205.5	-22.4	988.1	1049.6	10.7	2044.8	2255.1	-9.4
1946/47	998.3	1199.9	-26.7	1064.3	1051.1	19.3	2062.6	2251.0	-8.6
1947/48	1455.5	1242.6	6.8	1277.7	1079.5	43.2	2733.1	2322.2	21.2
1948/49	1610.4	1328.5	18.2	835.7	1040.9	-6.3	2446.1	2369.4	8.4
1949/50	1689.2	1362.0	24.0	1290.4	1091.2	44.6	2979.5	2453.2	32.1
1950/51	1021.1	1354.9	-25.0	881.4	1069.9	-1.2	1902.5	2424.8	-15.7
1951/52	1252.3	1405.7	-8.1	779.8	1013.0	-12.6	2032.1	2418.7	-9.9
1952/53	988.1	1312.2	-27.5	1000.8	957.6	12.2	1988.9	2269.8	-11.8
1953/54	1503.7	1290.9	10.4	1066.8	1003.8	19.6	2570.6	2294.7	14.0
1954/55	1592.6	1271.6	16.9	711.2	888.0	-20.3	2303.9	2159.6	2.1
1955/56	1152.2	1297.8	-15.4	1018.6	915.5	14.1	2170.8	2213.2	-3.8
1956/57	1392.0	1325.7	2.2	812.8	922.1	-8.9	2204.8	2247.8	-2.3
1957/58	1033.8	1334.9	-24.1	955.1	912.9	7.0	1988.9	2247.8	-11.8
1958/59	980.5	1230.2	-28.0	674.4	834.4	-24.4	1654.9	2064.6	-26.6
1959/60	1225.6	1156.8	-10.0	941.1	880.4	5.5	2166.7	2037.2	-4.0
1960/61	1389.4	1204.3	2.0	1187.5	914.2	33.1	2576.9	2118.4	14.2
1961/62	1406.0	1207.1	3.2	1074.4	966.5	20.4	2480.4	2173.6	10.0
1962/63	924.6	1185.2	-32.1	948.7	965.2	6.3	1873.3	2150.4	-17.0
1963/64	896.7	1168.5	-34.2	1144.3	1059.2	28.2	2041.0	2227.7	-9.5
1964/65	1108.9	1145.1	-18.6	1157.1	1102.4	29.7	2266.0	2247.5	0.5
1965/66	1333.6	1134.0	-2.1	811.6	1027.2	-9.0	2145.2	2161.2	-4.9
1966/67	1548.2	1162.4	13.6	1009.6	1014.3	13.1	2557.8	2176.7	13.4
1967/68	1270.0	1231.5	-6.8	758.2	976.2	-15.0	2028.2	2207.6	-10.1
1968/69	913.1	1234.8	-33.0	814.1	910.1	-8.8	1727.2	2144.9	-23.4
1969/70	1254.8	1263.9	-7.9	962.8	871.3	7.9	2217.6	2135.2	-1.7
1970/71	1390.3	1275.3	2.1	674.0	843.7	-24.5	2064.3	2119.0	-8.5
1971/72	1434.0	1252.4	5.3	920.0	825.8	3.1	2354.0	2078.3	4.4
1972/73	1274.0	1253.2	-6.5	863.0	846.8	-3.3	2137.0	2100.0	-5.3
1973/74	1646.0	1399.8	20.8	802.0	844.4	-10.1	2448.0	2244.2	8.5
1974/75	1661.0	1481.1	21.9	759.0	803.6	-14.9	2420.0	2284.7	7.3
1975/76	1375.0	1478.0	0.9	728.0	814.4	-18.4	2103.0	2292.4	-6.8
1976/77	1377.0	1466.6	1.1	821.0	794.6	-8.0	2198.0	2261.2	-2.6
1977/78	1459.0	1503.6	7.1	687.0	759.4	-23.0	2146.0	2263.0	-4.9
1978/79	1418.0	1458.0	4.1	862.0	771.4	-3.4	2280.0	2229.4	1.1
1979/80	1449.0	1415.6	6.4	941.0	807.8	5.5	2390.0	2223.4	5.9
1980/81	1636.0	1467.8	20.1	874.0	837.0	-2.1	2510.0	2304.8	11.3
1981/82	1517.0	1495.8	11.4	898.0	852.4	0.6	2415.0	2348.2	7.1
1982/83	1802.0	1564.4	32.3	711.0	857.2	-20.3	2513.0	2421.6	11.4
1983/84	1547.0	1590.2	13.6	563.0	797.4	-36.9	2110.0	2387.6	-6.5
1984/85	1361.2	1572.6	-0.1	1470.0	903.2	64.7	2831.2	2475.8	25.5
1985/86	1488.9	1543.2	9.3	976.0	923.6	9.4	2464.9	2466.8	9.3
1986/87	1890.0	1617.8	38.7	788.0	901.6	-11.7	2678.0	2519.4	18.7
1987/88	1642.0	1585.8	20.5	1091.0	977.6	22.3	2733.0	2563.4	21.2
1988/89	1942.0	1664.8	42.6	892.0	1043.4	0.0	2834.0	2708.2	25.6
1989/90	2135.0	1819.6	56.7	798.0	909.0	-10.6	2933.0	2728.6	30.0
1990/91	1483.0	1818.4	8.9	964.0	906.6	8.0	2447.0	2725.0	8.5
1991/92	1868.0	1814.0	37.1	1195.0	988.0	33.9	3063.0	2802.0	35.8
1992/93									
μ	1362.3			892.3			2255.8		
SD	266.5			171.3			305.9		
CV	19.6			19.2			13.6		
skew	0.3			0.6			0.2		
min	866.2			548.7			1452.9		
Q1	1190.0			787.4			2055.6		
Me	1374.2			868.1			2215.0		
Q2	1526.6			1002.1			2447.5		
max	2135.0			1470.0			3063.0		

Station V (Doune, Inverbeg):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1960/61				1229.6		36.9			
1961/62	1557.3		7.8	1160.5		29.2	2717.8		16.5
1962/63	1066.7		-26.2	1015.6		13.1	2082.3		-10.7
1963/64	1039.8		-28.0	1072.7		19.4	2112.5		-9.4
1964/65	1163.3		-19.5	1237.5	1143.2	37.8	2400.8		2.9
1965/66	1475.7	1260.6	2.1	880.6	1073.4	-1.9	2356.3	2333.9	1.0
1966/67	1751.9	1299.5	21.2	1073.6	1056.0	19.5	2825.5	2355.5	21.1
1967/68	1363.1	1358.8	-5.7	806.2	1014.1	-10.2	2169.3	2372.9	-7.0

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1968/69	1023.7	1355.5	-29.2	818.3	963.2	-8.9	1842.0	2318.8	-21.0
1969/70	1362.0	1395.3	-5.7	979.9	911.7	9.1	2341.9	2307.0	0.4
1970/71	1301.3	1360.4	-9.9	529.9	841.6	-41.0	1831.2	2202.0	-21.5
1971/72	1116.2	1233.3	-22.8	888.9	804.6	-1.0	2005.1	2037.9	-14.0
1972/73	1140.9	1188.8	-21.0	747.1	792.8	-16.8	1888.0	1981.6	-19.1
1973/74	1419.9	1268.1	-1.7	766.2	782.4	-14.7	2186.1	2050.5	-6.3
1974/75	1511.8	1298.0	4.6	761.0	738.6	-15.3	2272.8	2036.6	-2.6
1975/76	1240.1	1285.8	-14.2	733.3	779.3	-18.3	1973.4	2065.1	-15.4
1976/77	1271.0	1316.7	-12.0	793.3	760.2	-11.7	2064.3	2076.9	-11.5
1977/78	1450.0	1378.6	0.3	712.1	753.2	-20.7	2162.1	2131.7	-7.3
1978/79	1208.9	1336.4	-16.3	759.8	751.9	-15.4	1968.7	2088.3	-15.6
1979/80	1396.4	1313.3	-3.4	941.0	787.9	4.8	2337.4	2101.2	0.2
1980/81	1459.3	1357.1	1.0	822.6	805.8	-8.4	2281.9	2162.9	-2.2
1981/82	1518.1	1406.5	5.1	815.8	810.3	-9.2	2333.9	2216.8	0.1
1982/83	1756.3	1467.8	21.5	697.1	807.3	-22.4	2453.4	2275.1	5.2
1983/84	1399.1	1505.8	-3.2	532.8	761.9	-40.7	1931.9	2267.7	-17.2
1984/85	1233.7	1473.3	-14.6	1355.2	844.7	50.9	2588.9	2318.0	11.0
1985/86	1653.0	1512.0	14.4	943.6	868.9	5.1	2596.6	2380.9	11.3
1986/87	1769.3	1562.3	22.4	840.0	873.7	-6.5	2609.3	2436.0	11.9
1987/88	1740.5	1559.1	20.5	1100.8	954.5	22.6	2841.3	2513.6	21.8
1988/89	2048.6	1689.0	41.8	772.2	1002.4	-14.0	2820.8	2691.4	20.9
1989/90	2095.5	1861.4	45.0	826.1	896.5	-8.0	2921.6	2757.9	25.3
1990/91	1424.8	1815.7	-1.4	915.0	890.8	1.9	2339.8	2706.6	0.3
1991/92	1835.7	1829.0	27.0	1209.6	964.7	34.7	3045.3	2793.8	30.6
1992/93									
μ	1445.0			898.1			2332.3		
SD	280.9			199.9			339.6		
CV	19.4			22.3			14.6		
skew	0.6			0.5			0.4		
min	1023.7			529.9			1831.2		
Q1	1236.9			764.9			2073.3		
Me	1419.9			833.1			2333.9		
Q2	1605.1			1029.9			2592.7		
max	2095.5			1355.2			3045.3		

Station VI (Sallochy):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1960/61				951.9		27.3			
1961/62	1145.0		8.1	905.1		21.0	2050.1		14.1
1962/63	774.8		-26.9	737.0		-1.5	1511.8		-15.8
1963/64	782.3		-26.2	934.3		24.9	1716.6		-4.4
1964/65	860.3		-18.8	922.1	890.1	23.3	1782.4		-0.8
1965/66	1162.5	945.0	9.7	786.6	857.0	5.2	1949.1	1802.0	8.5
1966/67	1238.5	963.7	16.9	772.6	830.5	3.3	2011.1	1794.2	12.0
1967/68	1021.5	1013.0	-3.6	703.2	823.8	-6.0	1724.7	1836.8	-4.0
1968/69	770.6	1010.7	-27.3	666.5	770.2	-10.9	1437.1	1780.9	-20.0
1969/70	882.7	1015.2	-16.7	851.6	756.1	13.9	1734.3	1771.3	-3.4
1970/71	1150.9	1012.8	8.6	529.2	704.6	-29.2	1680.1	1717.5	-6.5
1971/72	1086.5	982.4	2.5	742.8	698.7	-0.7	1829.3	1681.1	1.8
1972/73	1032.5	984.6	-2.6	675.5	693.1	-9.7	1708.0	1677.8	-4.9
1973/74	1280.9	1086.7	20.9	665.4	692.9	-11.0	1946.3	1779.6	8.4
1974/75	1287.7	1167.7	21.5	663.8	655.3	-11.2	1951.5	1823.0	8.6
1975/76	1108.0	1159.1	4.6	697.4	689.0	-6.8	1805.4	1848.1	0.5
1976/77	1291.9	1200.2	21.9	689.6	678.3	-7.8	1981.5	1878.5	10.3
1977/78	1181.1	1229.9	11.5	608.6	665.0	-18.6	1789.7	1894.9	-0.4
1978/79	1014.3	1176.6	-4.3	707.5	673.4	-5.4	1721.8	1850.0	-4.1
μ	1059.6			747.9			1796.2		
SD	179.5			117.1			166.0		
CV	16.9			15.7			9.2		
skew	-0.4			0.4			-0.4		
min	770.6			529.2			1437.1		
Q1	915.6			671.0			1717.9		
Me	1097.3			707.5			1786.1		
Q2	1176.5			819.1			1948.4		
max	1291.9			951.9			2050.1		

Station VII (Arrochymore):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1969/70				732.4		19.2			
1970/71	895.9		-10.6	454.6		-26.0	1350.5		-16.2

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1971/72	836.7		-16.5	554.1		-9.8	1390.8		-13.7
1972/73	698.9		-30.3	573.3		-6.7	1272.2		-21.0
1973/74	1029.2		2.7	529.6	568.8	-13.8	1558.8		-3.3
1974/75	946.4	881.4	-5.6	552.6	532.8	-10.1	1499.0	1414.3	-7.0
1975/76	864.5	875.1	-13.7	514.2	544.8	-16.3	1378.7	1419.9	-14.4
1976/77	877.6	883.3	-12.4	625.0	558.9	1.7	1502.6	1442.3	-6.7
1977/78	994.3	942.4	-0.8	570.8	558.4	-7.1	1565.1	1500.8	-2.9
1978/79	920.4	920.6	-8.2	598.2	572.2	-2.7	1518.6	1492.8	-5.8
1979/80	1078.9	947.1	7.6	755.4	612.7	22.9	1834.3	1559.9	13.8
1980/81	1121.8	998.6	11.9	636.4	637.2	3.5	1758.2	1635.8	9.1
1981/82	948.7	1012.8	-5.3	577.9	627.7	-6.0	1526.6	1640.6	-5.3
1982/83	1165.8	1047.1	16.3	559.8	625.5	-8.9	1725.6	1672.7	7.1
1983/84	1101.3	1083.3	9.9	382.3	582.4	-37.8	1483.6	1665.7	-7.9
1984/85	893.6	1046.2	-10.8	1060.2	643.3	72.5	1953.8	1689.6	21.3
1985/86	986.7	1019.2	-1.6	628.1	641.7	2.2	1614.8	1660.9	0.2
1986/87	1228.7	1075.2	22.6	596.2	645.3	-3.0	1824.9	1720.5	13.3
1987/88	1051.1	1052.3	4.9	829.8	699.3	35.0	1880.9	1751.6	16.7
1988/89	1160.1	1064.0	15.7	569.7	736.8	-7.3	1729.8	1800.8	7.4
1989/90	1261.7	1137.7	25.9	591.0	643.0	-3.8	1852.7	1780.6	15.0
1990/91	985.1	1137.3	-1.7	629.6	643.3	2.4	1614.7	1780.6	0.2
1991/92									
μ	1002.3			614.6			1611.2		
SD	140.3			137.2			192.3		
CV	14.0			22.3			11.9		
skew	0.0			1.7			0.1		
min	698.9			382.3			1272.2		
Q1	895.9			555.5			1499.0		
Me	986.7			584.5			1565.1		
Q2	1101.3			629.2			1758.2		
max	1261.7			1060.2			1953.8		

Station VIII (Glen Finlas, resr. no.2 and resr. South):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1910/11				793.5		-12.6			
1911/12									
1912/13									
1913/14									
1914/15				588.8		-35.2			
1915/16									
1916/17									
1917/18				806.7		-11.2			
1918/19	1054.6		-11.0	694.7		-23.5	1749.4		-16.8
1919/20	1142.0		-3.7	907.3		-0.1	2049.4		-2.5
1920/21	1112.1		-6.2	777.8		-14.4	1889.8		-10.1
1921/22	1155.7		-2.5	823.5	802.0	-9.3	1979.2		-5.8
1922/23	1060.2	1104.9	-10.6	1034.1	847.5	13.8	2094.3	1952.4	-0.4
1923/24	872.5	1068.5	-26.4	1008.2	910.2	11.0	1880.7	1978.7	-10.5
1924/25	980.7	1036.3	-17.3	932.0	915.1	2.6	1912.7	1951.4	-9.0
1925/26	1037.4	1021.3	-12.5	785.9	916.7	-13.5	1823.3	1938.0	-13.3
1926/27	1153.7	1020.9	-2.7	1038.9	959.8	14.4	2192.6	1980.7	4.3
1927/28	1177.8	1044.4	-0.7	959.9	945.0	5.7	2137.7	1989.4	1.7
1928/29	1004.1	1070.8	-15.3	908.1	925.0	0.0	1912.2	1995.7	-9.0
1929/30	1273.4	1129.3	7.4	798.9	898.3	-12.0	2072.2	2027.6	-1.4
1930/31	1231.7	1168.1	3.9	923.6	925.9	1.7	2155.3	2094.0	2.5
1931/32	1343.2	1206.0	13.3	943.1	906.7	3.8	2286.3	2112.8	8.8
1932/33	1550.7	1280.6	30.8	816.1	878.0	-10.1	2366.9	2158.6	12.6
1933/34	934.0	1266.6	-21.2	898.2	876.0	-1.1	1832.2	2142.6	-12.8
1934/35	1219.8	1255.9	2.9	884.7	893.1	-2.6	2104.5	2149.0	0.1
1935/36	1216.7	1252.9	2.6	818.9	872.2	-9.8	2035.6	2125.1	-3.2
1936/37	1309.2	1246.1	10.4	979.2	879.4	7.8	2288.4	2125.5	8.9
1937/38	1079.0	1151.7	-9.0	1179.9	952.2	29.9	2258.9	2103.9	7.5
1938/39	1665.5	1298.0	40.5	846.4	941.8	-6.8	2511.9	2239.9	19.5
1939/40	1004.9	1255.1	-15.2	589.8	882.8	-35.1	1594.7	2137.9	-24.1
1940/41	1100.6	1231.8	-7.2	703.1	859.7	-22.6	1803.7	2091.5	-14.2
1941/42	941.9	1158.4	-20.6	1092.0	882.2	20.2	2033.9	2040.6	-3.2
1942/43	1320.9	1206.8	11.4	1210.6	888.4	33.3	2531.5	2095.1	20.4
1943/44	1244.4	1122.5	5.0	1013.0	921.7	11.5	2257.4	2044.2	7.4
1944/45	1387.4	1199.0	17.0	968.8	997.5	6.7	2356.2	2196.5	12.1
1945/46	1009.2	1180.7	-14.9	969.0	1050.7	6.7	1978.2	2231.4	-5.9
1946/47	987.6	1189.9	-16.7	1004.4	1033.2	10.6	1991.9	2223.0	-5.2
1947/48	1368.1	1199.3	15.4	1345.5	1060.1	48.1	2713.6	2259.5	29.1
1948/49	1568.5	1264.2	32.3	846.9	1026.9	-6.8	2415.4	2291.1	14.9
1949/50	1518.5	1290.4	28.1	1314.8	1096.1	44.8	2833.2	2386.5	34.8
1950/51	970.3	1282.6	-18.2	824.0	1067.1	-9.3	1794.3	2349.7	-14.6
1951/52	1227.6	1330.6	3.5	775.7	1021.4	-14.6	2003.4	2352.0	-4.7
1952/53	925.1	1242.0	-22.0	1046.3	961.5	15.2	1971.4	2203.5	-6.2

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1953/54	1324.4	1193.2	11.7	1163.9	1024.9	28.1	2488.3	2218.1	18.4
1954/55	1273.1	1144.1	7.4	823.0	926.6	-9.4	2096.1	2070.7	-0.3
1955/56	1051.3	1160.3	-11.3	999.5	961.7	10.0	2050.9	2122.0	-2.4
1956/57	1311.5	1177.1	10.6	901.2	986.8	-0.8	2212.7	2163.9	5.3
1957/58	1027.7	1197.6	-13.3	977.4	973.0	7.6	2005.2	2170.6	-4.6
1958/59	869.2	1106.6	-26.7	791.7	898.6	-12.8	1661.0	2005.2	-21.0
1959/60	1167.2	1085.4	-1.6	926.9	919.4	2.0	2094.1	2004.7	-0.4
1960/61	1320.1	1139.1	11.3	1226.9	964.8	35.1	2547.0	2104.0	21.2
1961/62	1240.7	1125.0	4.6	1167.7	1018.1	28.6	2408.4	2143.1	14.6
1962/63	855.2	1090.5	-27.9	956.8	1014.0	5.3	1812.0	2104.5	-13.8
1963/64	859.7	1088.6	-27.5	1103.1	1076.3	21.4	1962.8	2164.9	-6.6
1964/65	1183.7	1091.9	-0.2	842.3	1059.4	-7.3	2026.0	2151.2	-3.6
1965/66	1261.0	1080.1	6.4	902.5	994.5	-0.6	2163.5	2074.5	2.9
1966/67	1406.6	1113.2	18.6	1014.0	963.7	11.6	2420.6	2077.0	15.2
1967/68	1130.0	1168.2	-4.7	819.1	936.2	-9.8	1949.1	2104.4	-7.3
1968/69	863.5	1169.0	-27.2	815.9	878.8	-10.2	1679.4	2047.7	-20.1
1969/70	1012.5	1134.7	-14.6	723.1	854.9	-20.4	1735.6	1989.6	-17.4
1970/71	1183.6	1119.2	-0.2	600.6	794.5	-33.9	1784.2	1913.8	-15.1
1971/72	1117.6	1061.4	-5.7	872.0	766.1	-4.0	1989.6	1827.6	-5.3
1972/73	1107.7	1057.0	-6.6	842.7	770.9	-7.2	1950.4	1827.8	-7.2
1973/74	1384.0	1161.1	16.7	851.7	778.0	-6.2	2235.7	1939.1	6.4
1974/75	1499.1	1258.4	26.4	824.0	798.2	-9.3	2323.1	2056.6	10.5
1975/76	1173.4	1256.4	-1.0	748.5	827.8	-17.6	1921.9	2084.1	-8.6
1976/77	1267.9	1286.4	6.9	956.0	844.6	5.3	2223.9	2131.0	5.8
1977/78	1384.5	1341.8	16.8	813.6	838.8	-10.4	2198.1	2180.5	4.6
1978/79	1184.8	1301.9	-0.1	795.4	827.5	-12.4	1980.2	2129.4	-5.8
1979/80	1309.9	1264.1	10.5	1034.6	869.6	13.9	2344.5	2133.7	11.5
1980/81	1506.3	1330.7	27.1	815.5	883.0	-10.2	2321.8	2213.7	10.5
1981/82	1324.6	1342.0	11.7	802.9	852.4	-11.6	2127.5	2194.4	1.2
1982/83	1318.2	1328.8	11.2	685.5	826.8	-24.5	2003.7	2155.5	-4.7
1983/84	1389.6	1369.7	17.2	566.9	781.1	-37.6	1956.5	2150.8	-6.9
1984/85	975.9	1302.9	-17.7	1362.8	846.7	50.0	2338.7	2149.6	11.3
μ	1185.6			908.3			2101.9		
SD	191.3			170.8			254.3		
CV	16.1			18.8			12.1		
skew	0.2			0.6			0.5		
min	855.2			566.9			1594.7		
Q1	1032.6			808.5			1949.7		
Me	1183.6			891.4			2050.9		
Q2	1319.1			1003.1			2272.6		
max	1665.5			1362.8			2833.2		

Station IX (Blairnairn No.1):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1932/33				736.6		-4.1			
1933/34	711.0		-32.1	802.2		4.5	1513.1		-16.6
1934/35	1107.5		5.8	742.2		-3.3	1849.7		1.9
1935/36	1040.7		-0.5	696.5		-9.3	1737.2		-4.3
1936/37	1092.8		4.4	642.4	724.0	-16.3	1735.1		-4.4
1937/38	897.9	970.0	-14.2	845.9	745.8	10.2	1743.8	1715.8	-3.9
1938/39	1375.2	1102.8	31.4	659.4	717.3	-14.1	2034.6	1820.1	12.1
1939/40	824.0	1046.1	-21.2	515.9	672.0	-32.8	1339.9	1718.1	-26.2
1940/41	966.5	1031.3	-7.6	602.8	653.3	-21.5	1569.3	1684.5	-13.5
1941/42	839.8	980.7	-19.7	807.5	686.3	5.2	1647.3	1667.0	-9.2
1942/43	1008.9	1002.9	-3.6	877.1	692.5	14.2	1886.0	1695.4	3.9
1943/44	855.8	899.0	-18.2	812.1	723.1	5.8	1667.8	1622.1	-8.1
1944/45	1189.0	972.0	13.6	842.6	788.4	9.7	2031.6	1760.4	12.0
1945/46	867.2	952.1	-17.1	890.6	846.0	16.0	1757.7	1798.1	-3.1
1946/47	1003.1	984.8	-4.1	1022.6	889.0	33.2	2025.7	1873.8	11.6
1947/48	1236.5	1030.3	18.2	1192.1	952.0	55.3	2428.6	1982.3	33.8
1948/49	1537.8	1166.7	47.0	715.5	932.7	-6.8	2253.3	2099.4	24.2
1949/50	1352.1	1199.3	29.2	1002.3	964.6	30.5	2354.4	2164.0	29.7
1950/51	858.0	1197.5	-18.0	638.3	914.2	-16.9	1496.4	2111.7	-17.5
1951/52	1196.1	1236.1	14.3	605.6	830.8	-21.1	1801.7	2066.9	-0.7
1952/53	695.2	1127.9	-33.6	719.1	736.2	-6.3	1414.3	1864.0	-22.1
1953/54	1110.8	1042.5	6.2	934.2	779.9	21.7	2045.0	1822.4	12.7
1954/55	1325.4	1037.1	26.7	512.3	681.9	-33.3	1837.8	1719.0	1.3
1955/56	758.0	1017.1	-27.6	722.2	698.7	-5.9	1480.1	1715.8	-18.4
1956/57	982.0	974.3	-6.1	632.2	704.0	-17.7	1614.2	1678.3	-11.0
1957/58	738.7	983.0	-29.4	844.6	729.1	10.0	1583.2	1712.1	-12.8
1958/59	1072.9	975.4	2.5	731.3	688.5	-4.8	1804.2	1663.9	-0.6
1959/60	935.0	897.3	-10.6	730.5	732.2	-4.9	1665.5	1629.5	-8.2
1960/61	910.1	927.8	-13.0	865.3	760.8	12.7	1775.4	1688.5	-2.2
1961/62	982.6	927.9	-6.1	848.6	804.1	10.5	1831.2	1731.9	0.9
1962/63	664.1	913.0	-36.5	720.8	779.3	-6.1	1384.9	1692.3	-23.7

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1963/64	698.0	838.0	-33.3	940.0	821.0	22.4	1638.0	1659.0	-9.7
1964/65	843.1	819.6	-19.4	978.7	870.7	27.5	1821.8	1690.3	0.4
1965/66	1053.0	848.2	0.6	845.2	866.7	10.1	1898.2	1714.8	4.6
1966/67	1153.1	882.3	10.2	765.3	850.0	-0.3	1918.4	1732.3	5.7
1967/68	989.3	947.3	-5.4	750.6	856.0	-2.2	1739.9	1803.3	-4.1
1968/69	780.0	963.7	-25.5	680.8	804.1	-11.3	1460.8	1767.8	-19.5
1969/70	938.6	982.8	-10.3	794.3	767.2	3.4	1732.9	1750.0	-4.5
1970/71	1030.0	978.2	-1.6	558.0	709.8	-27.3	1588.0	1688.0	-12.5
1971/72	848.0	917.2	-19.0	631.0	682.9	-17.8	1479.0	1600.1	-18.5
1972/73	847.0	888.7	-19.0	614.0	655.6	-20.0	1461.0	1544.3	-19.5
1973/74	1086.0	949.9	3.8	693.0	658.1	-9.7	1779.0	1608.0	-2.0
1974/75	1077.0	977.6	2.9	613.0	621.8	-20.2	1690.0	1599.4	-6.9
1975/76	990.0	969.6	-5.4	614.0	633.0	-20.0	1604.0	1602.6	-11.6
1976/77	1059.0	1011.8	1.2	803.0	667.4	4.6	1862.0	1679.2	2.6
1977/78	1092.0	1060.8	4.4	733.0	691.2	-4.5	1825.0	1752.0	0.6
1978/79	1088.0	1061.2	4.0	770.0	706.6	0.3	1858.0	1767.8	2.4
1979/80	1187.0	1083.2	13.4	888.0	761.6	15.7	2075.0	1844.8	14.3
1980/81	1356.0	1156.4	29.6	748.8	788.6	-2.5	2104.8	1945.0	16.0
1981/82	1188.0	1182.2	13.5	788.0	785.6	2.6	1976.0	1967.8	8.9
1982/83	1255.0	1214.8	19.9	740.0	787.0	-3.6	1995.0	2001.8	9.9
1983/84	1158.0	1228.8	10.7	492.0	731.4	-35.9	1650.0	1960.2	-9.1
1984/85	1006.1	1192.6	-3.8	1164.5	786.7	51.7	2170.6	1979.3	19.6
1985/86	1141.0	1149.6	9.0	751.0	787.1	-2.2	1892.0	1936.7	4.3
1986/87	1457.0	1203.4	39.2	726.0	774.7	-5.4	2183.0	1978.1	20.3
1987/88	1097.0	1171.8	4.8	948.0	816.3	23.5	2045.0	1988.1	12.7
1988/89	1342.0	1208.6	28.3	697.0	857.3	-9.2	2039.0	2065.9	12.4
1989/90	1429.0	1293.2	36.6	762.0	776.8	-0.8	2191.0	2070.0	20.7
1990/91	1096.0	1284.2	4.7	699.0	766.4	-9.0	1795.0	2050.6	-1.1
1991/92	1314.0	1255.6	25.6	970.0	815.2	26.3	2284.0	2070.8	25.9
1992/93									
μ	1046.3			767.8			1814.7		
SD	206.3			143.9			252.4		
CV	19.7			18.7			13.9		
skew	0.2			0.7			0.3		
min	664.1			492.0			1339.9		
Q1	882.6			690.0			1642.6		
Me	1053.0			745.5			1801.7		
Q2	1172.5			845.4			2010.4		
max	1537.8			1192.1			2428.6		

Station X (Balfron: High School, the Old Manse, Old Stables, Old Ballinkinrain):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1932/33				402.1		-25.2			
1933/34	504.7		-32.2	585.2		8.9	1090.0		-15.1
1934/35	784.4		5.3	575.1		7.0	1359.5		5.8
1935/36	877.4		17.8	429.5		-20.1	1306.9		1.7
1936/37	820.7		10.2	524.0	503.2	-2.5	1344.7		4.7
1937/38	553.0	708.0	-25.8	546.9	532.2	1.8	1099.9	1240.2	-14.4
1938/39	942.9	795.7	26.6	458.5	506.8	-14.7	1401.4	1302.5	9.1
1939/40	637.8	766.3	-14.4	377.7	467.3	-29.7	1015.5	1233.7	-20.9
1940/41	720.1	734.9	-3.3	382.0	457.8	-28.9	1102.1	1192.7	-14.2
1941/42	669.1	704.6	-10.2	540.8	461.2	0.7	1209.8	1165.8	-5.8
1942/43	753.9	744.8	1.2	650.5	481.9	21.1	1404.4	1226.7	9.3
1943/44	639.3	684.0	-14.2	609.9	512.2	13.5	1249.2	1196.2	-2.7
1944/45	1008.4	758.2	35.4	694.2	575.5	29.2	1702.6	1333.7	32.6
1945/46	752.4	764.6	1.0	542.3	607.5	0.9	1294.7	1372.2	0.8
1946/47	671.1	765.0	-9.9	651.3	629.6	21.2	1322.4	1394.7	2.9
1947/48	725.7	759.4	-2.6	759.5	651.4	41.4	1485.2	1410.8	15.6
1948/49	808.3	793.2	8.5	527.1	634.9	-1.9	1335.3	1428.1	4.0
1949/50	895.9	770.7	20.3	771.9	650.4	43.7	1667.8	1421.1	29.8
1950/51	663.0	752.8	-11.0	557.0	653.4	3.7	1220.0	1406.1	-5.0
1951/52	729.5	764.5	-2.1	467.6	616.6	-13.0	1197.1	1381.1	-6.8
1952/53	501.2	719.6	-32.7	547.6	574.3	1.9	1048.8	1293.8	-18.3
1953/54	822.7	722.5	10.4	681.3	605.1	26.8	1504.0	1327.6	17.1
1954/55	863.1	715.9	15.9	401.3	531.0	-25.3	1264.5	1246.9	-1.6
1955/56	601.2	703.6	-19.3	594.6	538.5	10.7	1195.9	1242.1	-6.9
1956/57	719.9	701.6	-3.4	467.9	538.6	-12.9	1187.8	1240.2	-7.5
1957/58	608.4	723.1	-18.3	636.3	556.3	18.4	1244.6	1279.3	-3.1
1958/59	536.7	665.9	-28.0	441.0	508.2	-17.9	977.7	1174.1	-23.9
1959/60	816.6	656.6	9.6	506.2	529.2	-5.8	1322.9	1185.8	3.0
1960/61	782.3	692.8	5.0	656.7	541.6	22.2	1439.0	1234.4	12.0
1961/62	820.1	712.8	10.1	609.3	569.9	13.4	1429.4	1282.7	11.3

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1962/63	520.7	695.3	-30.1	565.1	555.7	5.2	1085.8	1251.0	-15.5
1963/64	549.0	697.7	-26.3	620.4	591.5	15.5	1169.4	1289.3	-9.0
1964/65	626.6	659.7	-15.9	711.2	632.5	32.4	1337.8	1292.3	4.1
1965/66	709.1	645.1	-4.8	594.9	620.2	10.7	1304.0	1265.3	1.5
1966/67	780.1	637.1	4.7	481.6	594.6	-10.4	1261.7	1231.7	-1.8
1967/68	723.9	677.7	-2.8	552.9	592.2	2.9	1276.8	1269.9	-0.6
1968/69	538.5	675.6	-27.7	469.9	562.1	-12.5	1008.4	1237.7	-21.5
1969/70	633.7	677.1	-14.9	552.4	530.3	2.8	1186.1	1207.4	-7.7
1970/71	683.4	671.9	-8.3	449.3	501.2	-16.4	1132.7	1173.1	-11.8
1971/72	655.8	647.1	-12.0	474.1	499.7	-11.8	1129.9	1146.8	-12.0
1972/73	580.6	618.4	-22.1	518.7	492.9	-3.5	1099.3	1111.3	-14.4
1973/74	852.5	681.2	14.4	432.2	485.3	-19.6	1284.7	1166.5	0.0
1974/75	790.2	712.5	6.1	453.6	465.6	-15.6	1243.8	1178.1	-3.2
1975/76	678.6	711.5	-8.9	472.9	470.3	-12.0	1151.5	1181.8	-10.4
1976/77	749.4	730.3	0.6	461.2	467.7	-14.2	1210.6	1198.0	-5.8
1977/78	828.4	779.8	11.2	452.4	454.5	-15.8	1280.8	1234.3	-0.3
1978/79	620.4	733.4	-16.7	464.0	460.8	-13.6	1084.4	1194.2	-15.6
1979/80	789.6	733.3	6.0	523.4	474.8	-2.6	1313.0	1208.1	2.2
1980/81	834.3	764.4	12.0	589.9	498.2	9.8	1424.2	1262.6	10.9
1981/82	810.8	776.7	8.8	547.6	515.5	1.9	1358.4	1292.2	5.8
1982/83	987.9	808.6	32.6	446.2	514.2	-16.9	1434.1	1322.8	11.6
1983/84	830.0	850.5	11.4	265.8	474.6	-50.5	1095.8	1325.1	-14.7
1984/85	762.7	845.1	2.4	853.2	540.5	58.8	1615.9	1385.7	25.8
1985/86	696.7	817.6	-6.5	485.3	519.6	-9.7	1182.0	1337.2	-8.0
1986/87	980.4	851.5	31.6	465.3	503.2	-13.4	1445.7	1354.7	12.5
1987/88	795.4	813.0	6.8	649.9	543.9	21.0	1445.3	1356.9	12.5
1988/89	903.0	827.6	21.2	442.7	579.3	-17.6	1345.7	1406.9	4.8
1989/90	1048.5	884.8	40.7	471.5	502.9	-12.2	1520.0	1387.7	18.3
1990/91	811.4	907.7	8.9	504.7	506.8	-6.1	1316.1	1414.6	2.5
1991/92	951.7	902.0	27.8	667.4	547.2	24.2	1619.1	1449.2	26.0
1992/93									
μ	745.0			537.3			1284.5		
SD	132.4			107.4			165.1		
CV	17.8			20.0			12.8		
skew	0.1			0.5			0.4		
min	501.2			265.8			977.7		
Q1	647.6			463.3			1175.7		
Me	752.4			525.5			1280.8		
Q2	821.7			598.5			1380.4		
max	1048.5			853.2			1702.6		

Station XI (Loch Lomond):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1921/22				496.8		-18.9			
1922/23	585.7		-27.7	684.0		11.7	1269.8		-10.9
1923/24	608.4		-24.9	716.1		16.9	1324.4		-7.1
1924/25	741.5		-8.5	618.5		1.0	1360.0		-4.6
1925/26	680.5		-16.0	545.6	612.2	-10.9	1226.1		-14.0
1926/27	871.5	697.5	7.5	937.0	700.3	52.9	1808.6	1397.8	26.9
1927/28	952.8	770.9	17.5	681.3	699.7	11.2	1634.0	1470.6	14.7
1928/29	693.2	787.9	-14.5	575.8	671.7	-6.0	1269.0	1459.5	-10.9
1929/30	867.4	813.1	7.0	622.3	672.4	1.6	1489.8	1485.5	4.6
1930/31	829.1	842.8	2.3	569.5	677.2	-7.0	1398.6	1520.0	-1.8
1931/32	732.8	815.1	-9.6	528.6	595.5	-13.7	1261.4	1410.6	-11.5
1932/33	915.2	807.5	12.9	450.6	549.4	-26.4	1365.8	1356.9	-4.1
1933/34	576.9	784.3	-28.8	766.9	587.6	25.2	1343.7	1371.9	-5.7
1934/35	854.5	781.7	5.4	514.4	566.0	-16.0	1368.9	1347.7	-3.9
1935/36	903.8	796.6	11.5	480.8	548.3	-21.5	1384.6	1344.9	-2.8
1936/37	1035.6	857.2	27.8	582.4	559.0	-4.9	1618.0	1416.2	13.6
1937/38	682.3	810.6	-15.8	733.6	615.6	19.7	1415.9	1426.2	-0.6
1938/39	1017.8	898.8	25.6	465.9	555.4	-24.0	1483.7	1454.2	4.1
1939/40	616.0	851.1	-24.0	500.7	552.7	-18.3	1116.6	1403.8	-21.6
1940/41	811.6	832.6	0.1	490.7	554.7	-19.9	1302.3	1387.3	-8.6
1941/42	686.1	762.7	-15.4	658.9	569.9	7.5	1345.0	1332.7	-5.6
1942/43	785.4	783.4	-3.1	771.4	577.5	25.9	1556.8	1360.9	9.3
1943/44	711.2	722.0	-12.3	604.0	605.2	-1.4	1315.3	1327.2	-7.7
1944/45	885.2	775.9	9.2	631.0	631.2	3.0	1516.2	1407.1	6.4
1945/46	647.2	743.0	-20.2	631.5	659.4	3.1	1278.7	1402.4	-10.3
1946/47	694.0	744.6	-14.4	676.4	662.9	10.4	1370.4	1407.5	-3.8
1947/48	884.2	764.4	9.1	852.7	679.1	39.2	1736.9	1443.5	21.9
1948/49	996.7	821.5	23.0	498.9	658.1	-18.6	1495.6	1479.6	5.0
1949/50	950.5	834.5	17.3	893.9	710.7	45.9	1844.4	1545.2	29.4

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1950/51	680.7	841.2	-16.0	587.8	701.9	-4.1	1268.5	1543.2	-11.0
1951/52	814.9	865.4	0.5	523.5	671.3	-14.6	1338.4	1536.8	-6.1
1952/53	685.3	825.6	-15.5	642.6	629.3	4.9	1328.0	1455.0	-6.8
1953/54	924.6	811.2	14.1	827.8	695.1	35.1	1752.4	1506.3	23.0
1954/55	964.2	813.9	19.0	611.1	638.6	-0.2	1575.4	1452.5	10.6
1955/56	747.6	827.3	-7.8	703.1	661.6	14.8	1450.7	1489.0	1.8
1956/57	865.7	837.5	6.8	581.7	673.3	-5.1	1447.3	1510.7	1.6
1957/58	733.6	847.1	-9.5	755.7	695.9	23.3	1489.3	1543.0	4.5
1958/59	657.6	793.7	-18.9	535.5	637.4	-12.6	1193.1	1431.1	-16.3
1959/60	802.7	761.4	-1.0	596.4	634.5	-2.7	1399.1	1395.9	-1.8
1960/61	789.9	769.9	-2.6	770.9	648.0	25.8	1560.8	1417.9	9.5
1961/62	887.6	774.3	9.5	696.2	670.9	13.6	1583.8	1445.2	11.2
1962/63	520.2	731.6	-35.8	562.3	632.3	-8.2	1082.5	1363.9	-24.0
1963/64	558.0	711.7	-31.2	698.6	664.9	14.0	1256.6	1376.6	-11.8
1964/65	708.3	692.8	-12.6	775.9	700.8	26.6	1484.2	1393.6	4.2
1965/66	836.9	702.2	3.2	627.4	672.1	2.4	1464.3	1374.3	2.8
1966/67	854.1	695.5	5.4	592.4	651.3	-3.3	1446.5	1346.8	1.5
1967/68	780.8	747.6	-3.7	585.3	655.9	-4.5	1366.1	1403.5	-4.1
1968/69	610.0	758.0	-24.7	537.1	623.6	-12.3	1147.1	1381.6	-19.5
1969/70	738.6	764.1	-8.9	632.9	595.0	3.3	1371.5	1359.1	-3.7
1970/71	842.3	765.2	3.9	434.4	556.4	-29.1	1276.7	1321.6	-10.4
1971/72	698.2	734.0	-13.9	471.4	532.2	-23.1	1169.6	1266.2	-17.9
1972/73	647.9	707.4	-20.1	545.7	524.3	-10.9	1193.6	1231.7	-16.2
1973/74	964.1	778.2	18.9	510.0	518.9	-16.8	1474.1	1297.1	3.5
1974/75	796.7	789.8	-1.7	516.1	495.5	-15.8	1312.8	1285.4	-7.9
1975/76	732.6	767.9	-9.6	494.9	507.6	-19.2	1227.5	1275.5	-13.9
1976/77	712.4	770.7	-12.1	582.5	529.8	-4.9	1294.9	1300.6	-9.1
1977/78	916.0	824.4	13.0	531.4	527.0	-13.3	1447.4	1351.3	1.6
1978/79	714.3	774.4	-11.9	524.0	529.8	-14.5	1238.3	1304.2	-13.1
1979/80	935.9	802.2	15.5	663.8	559.3	8.3	1599.7	1361.6	12.3
1980/81	980.8	851.9	21.0	606.9	581.7	-0.9	1587.7	1433.6	11.4
1981/82	878.7	885.1	8.4	594.6	584.1	-2.9	1473.3	1469.3	3.4
1982/83	1012.2	904.4	24.9	474.9	572.8	-22.5	1487.1	1477.2	4.4
1983/84	893.6	940.2	10.2	312.8	530.6	-48.9	1206.4	1470.8	-15.3
1984/85	740.2	901.1	-8.7	973.7	592.6	58.9	1713.9	1493.7	20.3
1985/86	798.8	864.7	-1.5	610.7	593.3	-0.3	1409.5	1458.0	-1.1
1986/87	1112.7	911.5	37.3	539.2	582.3	-12.0	1651.9	1493.8	15.9
1987/88	931.9	895.4	15.0	667.0	620.7	8.9	1598.9	1516.1	12.2
1988/89	963.3	909.4	18.8	495.9	657.3	-19.1	1459.2	1566.7	2.4
1989/90	1139.7	989.3	40.6	555.0	573.6	-9.4	1694.7	1562.8	18.9
1990/91	855.0	1000.5	5.5	600.7	571.6	-2.0	1455.7	1572.1	2.2
1991/92	1095.4	997.1	35.1	768.8	617.5	25.5	1864.2	1614.5	30.8
1992/93									
μ	810.6			612.7			1424.9		
SD	140.3			122.0			176.0		
CV	17.3			19.9			12.4		
skew	0.2			0.7			0.5		
min	520.2			312.8			1082.5		
Q1	700.7			526.3			1296.8		
Me	807.1			594.6			1404.3		
Q2	912.3			678.8			1511.0		
max	1139.7			973.7			1864.2		

Station XII (Helensburgh):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1870/71				495.0		-12.6			
1871/72	915.0		16.7	854.0		50.9	1769.0		30.8
1872/73	748.0		-4.6	506.0		-10.6	1254.0		-7.3
1873/74	711.0		-9.4	541.0		-4.4	1252.0		-7.4
1874/75	798.0	793.0	1.7	501.0	579.4	-11.5	1299.0		-3.9
1875/76	955.0	825.4	21.8	550.0	590.4	-2.8	1505.0	1415.8	11.3
1876/77	869.0	816.2	10.8	703.0	560.2	24.2	1572.0	1376.4	16.3
1877/78	876.0	841.8	11.7	574.0	573.8	1.4	1450.0	1415.6	7.2
1878/79	534.0	806.4	-31.9	736.0	612.8	30.0	1270.0	1419.2	-6.1
1879/80	553.0	757.4	-29.5	379.0	588.4	-33.0	932.0	1345.8	-31.1
1880/81	547.0	675.8	-30.3	601.0	598.6	6.2	1148.0	1274.4	-15.1
1881/82	853.0	672.6	8.7	674.0	592.8	19.1	1527.0	1265.4	12.9
1882/83	923.0	682.0	17.7	525.0	583.0	-7.3	1448.0	1265.0	7.1
1883/84	1080.0	791.2	37.7	534.0	542.6	-5.7	1614.0	1333.8	19.4
1884/85	907.0	862.0	15.6	570.0	580.8	0.7	1477.0	1442.8	9.2
1885/86	712.0	895.0	-9.2	536.0	567.8	-5.3	1248.0	1462.8	-7.7

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1886/87	714.0	867.2	-9.0	446.0	522.2	-21.2	1160.0	1389.4	-14.2
1887/88	518.0	786.2	-34.0	579.0	533.0	2.3	1097.0	1319.2	-18.9
1888/89	647.0	699.6	-17.5	522.0	530.6	-7.8	1169.0	1230.2	-13.5
1889/90	628.0	643.8	-19.9	614.0	539.4	8.5	1242.0	1183.2	-8.1
1890/91	565.0	614.4	-28.0	510.0	534.2	-9.9	1075.0	1148.6	-20.5
1891/92	641.0	599.8	-18.3	719.0	588.8	27.0	1360.0	1188.6	0.6
1892/93	512.0	598.6	-34.7	475.0	568.0	-16.1	987.0	1166.6	-27.0
1893/94	888.0	646.8	13.2	380.0	539.6	-32.9	1268.0	1186.4	-6.2
1894/95	411.0	603.4	-47.6	471.0	511.0	-16.8	882.0	1114.4	-34.8
1895/96	628.0	616.0	-19.9	433.0	495.6	-23.5	1061.0	1111.6	-21.5
1896/97	467.0	581.2	-40.5	575.0	466.8	1.6	1042.0	1048.0	-22.9
1897/98	477.0	574.2	-39.2	577.0	487.2	1.9	1054.0	1061.4	-22.1
1898/99	794.0	555.4	1.2	454.0	502.0	-19.8	1248.0	1057.4	-7.7
1899/1900		591.5			509.8			1101.3	
1900/01		579.3		428.0	508.5	-24.4		1114.7	
1901/02	534.0	601.7	-31.9	420.0	469.8	-25.8	954.0	1085.3	-29.4
1902/03	748.0	692.0	-4.6	572.0	468.5	1.0	1320.0	1174.0	-2.4
1903/04	691.0	657.7	-11.9	457.0	469.3	-19.3	1148.0	1140.7	-15.1
1904/05	510.0	620.8	-35.0	409.0	457.2	-27.7	919.0	1085.3	-32.0
1905/06	644.0	625.4	-17.9	425.0	456.6	-24.9	1069.0	1082.0	-20.9
1906/07	694.0	657.4	-11.5	560.0	484.6	-1.1	1254.0	1142.0	-7.3
1907/08	700.0	647.8	-10.8	533.0	476.8	-5.8	1233.0	1124.6	-8.8
1908/09	456.7	600.9	-41.8	525.0	490.4	-7.3	981.7	1091.3	-27.4
1909/10	899.1	678.8	14.6	656.5	539.9	16.0	1555.5	1218.6	15.0
1910/11	732.0	696.4	-6.7	558.0	566.5	-1.4	1290.0	1262.8	-4.6
1911/12	1002.0	758.0	27.7	584.0	571.3	3.2	1586.0	1329.2	17.3
1912/13	1074.0	832.8	36.9	493.0	563.3	-12.9	1567.0	1396.0	15.9
1913/14	789.0	899.2	0.6	478.0	553.9	-15.6	1267.0	1453.1	-6.3
1914/15	937.0	906.8	19.5	364.0	495.4	-35.7	1301.0	1402.2	-3.8
1915/16	689.0	898.2	-12.2	476.0	479.0	-15.9	1165.0	1377.2	-13.8
1916/17	765.0	850.8	-2.5	548.0	471.8	-3.2	1313.0	1322.6	-2.9
1917/18	996.0	835.2	27.0	500.0	473.2	-11.7	1496.0	1308.4	10.6
1918/19	820.0	841.4	4.5	442.0	466.0	-21.9	1262.0	1307.4	-6.7
1919/20	914.0	836.8	16.5	637.0	520.6	12.5	1551.0	1357.4	14.7
1920/21	837.0	866.4	6.7	565.0	538.4	-0.2	1402.0	1404.8	3.7
1921/22	891.0	891.6	13.6	553.0	539.4	-2.3	1444.0	1431.0	6.8
1922/23	709.0	834.2	-9.6	728.0	585.0	28.6	1437.0	1419.2	6.3
1923/24	706.0	811.4	-10.0	674.0	631.4	19.1	1380.0	1442.8	2.1
1924/25	772.0	783.0	-1.6	662.0	636.4	16.9	1434.0	1419.4	6.0
1925/26	752.0	766.0	-4.1	546.0	632.6	-3.5	1298.0	1398.6	-4.0
1926/27	902.0	768.2	15.0	794.0	680.8	40.3	1696.0	1449.0	25.4
1927/28	1006.0	827.6	28.3	626.0	660.4	10.6	1632.0	1488.0	20.7
1928/29	783.0	843.0	-0.2	557.0	637.0	-1.6	1340.0	1480.0	-0.9
1929/30	961.0	880.8	22.5	571.0	618.8	0.9	1532.0	1499.6	13.3
1930/31	821.0	894.6	4.7	503.0	610.2	-11.1	1324.0	1504.8	-2.1
1931/32	706.0	855.4	-10.0	485.0	548.4	-14.3	1191.0	1403.8	-11.9
1932/33	938.0	841.8	19.6	450.0	513.2	-20.5	1388.0	1355.0	2.6
1933/34	488.0	782.8	-37.8	615.0	524.8	8.6	1103.0	1307.6	-18.4
1934/35	872.0	765.0	11.2	569.0	524.4	0.5	1441.0	1289.4	6.6
1935/36	890.0	778.8	13.5	472.0	518.2	-16.6	1362.0	1297.0	0.7
1936/37	1009.0	839.4	28.6	510.0	523.2	-9.9	1519.0	1362.6	12.3
1937/38	641.0	780.0	-18.3	608.0	554.8	7.4	1249.0	1334.8	-7.6
1938/39	1081.0	898.6	37.8	506.0	533.0	-10.6	1587.0	1431.6	17.4
1939/40	680.0	860.2	-13.3	387.0	496.6	-31.6	1067.0	1356.8	-21.1
1940/41	775.0	837.2	-1.2	468.0	495.8	-17.3	1243.0	1333.0	-8.1
1941/42	751.0	785.6	-4.3	606.0	515.0	7.1	1357.0	1300.6	0.4
1942/43	821.0	821.6	4.7	741.0	541.6	30.9	1562.0	1363.2	15.5
1943/44	725.0	750.4	-7.6	659.0	572.2	16.4	1384.0	1322.6	2.4
1944/45	922.0	798.8	17.5	737.0	642.2	30.2	1659.0	1441.0	22.7
1945/46	723.0	788.4	-7.8	597.0	668.0	5.5	1320.0	1456.4	-2.4
1946/47	670.0	772.2	-14.6	701.0	687.0	23.8	1371.0	1459.2	1.4
1947/48	880.0	784.0	12.2	774.0	693.6	36.7	1654.0	1477.6	22.3
1948/49	970.0	833.0	23.7	526.0	667.0	-7.1	1496.0	1500.0	10.6
1949/50	972.0	843.0	23.9	813.0	682.2	43.6	1785.0	1525.2	32.0
1950/51	689.0	836.2	-12.2	486.0	660.0	-14.1	1175.0	1496.2	-13.1
1951/52	791.0	860.4	0.8	486.0	617.0	-14.1	1277.0	1477.4	-5.6
1952/53	605.0	805.4	-22.9	608.0	583.8	7.4	1213.0	1389.2	-10.3
1953/54	899.0	791.2	14.6	734.0	625.4	29.7	1633.0	1416.6	20.8
1954/55	880.0	772.8	12.2	471.0	557.0	-16.8	1351.0	1329.8	-0.1
1955/56	654.0	765.8	-16.6	612.0	582.2	8.1	1266.0	1348.0	-6.4
1956/57	849.0	777.4	8.2	574.0	599.8	1.4	1423.0	1377.2	5.2
1957/58	604.0	777.2	-23.0	674.0	613.0	19.1	1278.0	1390.2	-5.5
1958/59	538.0	705.0	-31.4	470.0	560.2	-17.0	1008.0	1265.2	-25.5
1959/60	785.0	686.0	0.1	575.0	581.0	1.6	1360.0	1267.0	0.6
1960/61	776.2	710.4	-1.0	714.0	601.4	26.1	1490.2	1311.8	10.2

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1961/62	881.7	717.0	12.4	681.8	623.0	20.4	1563.5	1339.9	15.6
1962/63	522.7	700.7	-33.4	549.0	598.0	-3.0	1071.7	1298.7	-20.7
1963/64	518.8	696.9	-33.9	706.3	645.2	24.8	1225.1	1342.1	-9.4
1964/65	687.8	677.4	-12.3	783.6	686.9	38.4	1471.4	1364.4	8.8
1965/66	786.9	679.6	0.3	620.6	668.3	9.6	1407.5	1347.8	4.1
1966/67	844.2	672.1	7.6	490.0	629.9	-13.4	1334.2	1302.0	-1.3
1967/68	750.0	717.5	-4.4	601.3	640.4	6.2	1351.3	1357.9	-0.1
1968/69	487.1	711.2	-37.9	497.5	598.6	-12.1	984.6	1309.8	-27.2
1969/70	686.5	710.9	-12.5	544.5	550.8	-3.8	1231.0	1261.7	-9.0
1970/71	863.4	726.2	10.1	457.5	518.2	-19.2	1320.9	1244.4	-2.3
1971/72	699.6	697.3	-10.8	497.2	519.6	-12.2	1196.8	1216.9	-11.5
1972/73	613.9	670.1	-21.7	527.1	504.8	-6.9	1141.1	1174.9	-15.6
1973/74	821.5	737.0	4.7	440.8	493.4	-22.1	1262.4	1230.4	-6.6
1974/75	807.3	761.2	2.9	488.9	482.3	-13.6	1296.2	1243.5	-4.1
1975/76	711.3	730.7	-9.3	452.4	481.3	-20.1	1163.7	1212.0	-13.9
1976/77	802.0	751.2	2.2	501.7	482.2	-11.4	1303.7	1233.4	-3.6
1977/78	894.9	807.4	14.1	530.7	482.9	-6.2	1425.6	1290.3	5.4
1978/79	807.3	804.6	2.9	563.7	507.5	-0.4	1371.0	1312.0	1.4
1979/80	972.3	837.6	24.0	566.9	523.1	0.1	1539.1	1360.6	13.8
1980/81	966.0	888.5	23.2	590.5	550.7	4.3	1556.5	1439.2	15.1
1981/82	878.6	903.8	12.0	631.9	576.7	11.6	1510.5	1480.6	11.7
1982/83	1068.4	938.5	36.2	499.5	570.5	-11.8	1567.9	1509.0	16.0
1983/84	938.1	964.7	19.6	362.1	530.2	-36.0	1300.2	1494.9	-3.8
1984/85	873.5	944.9	11.4	905.0	597.8	59.9	1778.5	1542.7	31.5
1985/86	854.4	922.6	8.9	611.7	602.0	8.1	1466.1	1524.6	8.4
1986/87	1181.9	983.3	50.7	616.9	599.0	9.0	1798.8	1582.3	33.0
1987/88	962.8	962.1	22.7	735.9	646.3	30.0	1698.7	1608.5	25.6
1988/89	1067.6	988.0	36.1	533.8	680.7	-5.7	1601.4	1668.7	18.4
1989/90	1168.7	1047.1	49.0	600.1	619.7	6.0	1768.8	1666.8	30.8
1990/91	884.2	1053.0	12.7	594.7	616.3	5.1	1478.9	1669.3	9.4
1991/92	1147.9	1046.2	46.3	803.6	653.6	42.0	1951.5	1699.9	44.3
1992/93									
μ	784.4			566.1			1352.2		
SD	168.3			108.5			213.4		
CV	21.5			19.2			15.8		
skew	0.0			0.7			0.2		
min	411.0			362.1			882.0		
Q1	687.2			490.0			1232.0		
Me	789.0			553.0			1334.2		
Q2	897.0			615.0			1500.5		
max	1181.9			905.0			1951.5		

Station XIII (Glasgow Airport):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1919/20									
1920/21	595		2	368		-16	963	963	-6
1921/22	582		0	357		-18	939	951	-8
1922/23	455		-22	516		18	971	958	-5
1923/24	433		-26	462		6	895	942	-12
1924/25	577	528	-1	505	442	16	1082	970	6
1925/26	536	517	-8	408	450	-7	944	966	-7
1926/27	650	530	12	602	499	38	1252	1029	23
1927/28	719	583	23	441	484	1	1160	1067	14
1928/29	534	603	-8	394	470	-10	928	1073	-9
1929/30	758	639	30	467	462	7	1225	1102	20
1930/31	593	651	2	453	471	4	1046	1122	3
1931/32	568	634	-2	404	432	-8	972	1066	-5
1932/33	718	634	23	318	407	-27	1036	1041	2
1933/34	355	598	-39	469	422	7	824	1021	-19
1934/35	511	549	-12	426	414	-2	937	963	-8
1935/36	626	556	7	396	403	-9	1022	958	0
1936/37	671	576	15	366	395	-16	1037	971	2
1937/38	480	529	-18	456	423	4	936	951	-8
1938/39	816	621	40	327	394	-25	1143	1015	12
1939/40	529	624	-9	331	375	-24	860	1000	-16
1940/41	606	620	4	350	366	-20	956	986	-6
1941/42	523	591	-10	463	385	6	986	976	-3
1942/43	624	620	7	528	400	21	1152	1019	13
1943/44	490	554	-16	487	432	11	977	986	-4
1944/45	731	595	25	547	475	25	1278	1070	25
1945/46	493	572	-15	453	496	4	946	1068	-7
1946/47	518	571	-11	561	515	28	1079	1086	6

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1947/48	640	574	10	607	531	39	1247	1105	22
1948/49	620	600	6	409	515	-6	1029	1116	1
1949/50	714	597	23	618	530	41	1332	1127	31
1950/51	471	593	-19	430	525	-2	901	1118	-12
1951/52	562	601	-4	372	487	-15	934	1089	-8
1952/53	346	543	-41	427	451	-2	773	994	-24
1953/54	627	544	8	499	469	14	1126	1013	10
1954/55	696	540	19	292	404	-33	988	944	-3
1955/56	420	530	-28	470	412	8	890	942	-13
1956/57	534	525	-8	384	414	-12	918	939	-10
1957/58	429	541	-26	468	423	7	897	964	-12
1958/59	352	486	-40	316	386	-28	668	872	-34
1959/60	633	474	9	438	415	0	1071	889	5
1960/61	549	499	-6	483	418	11	1032	917	1
1961/62	610	515	5	509	443	17	1119	957	10
1962/63	356	500	-39	398	429	-9	754	929	-26
1963/64	428	515	-27	509	467	17	937	983	-8
1964/65	439	476	-25	535	487	22	974	963	-4
1965/66	498	466	-15	489	488	12	987	954	-3
1966/67	631	470	8	411	468	-6	1042	939	2
1967/68	580	515	0	461	481	6	1041	996	2
1968/69	421	514	-28	394	458	-10	815	972	-20
1969/70	521	530	-11	414	434	-5	935	964	-8
1970/71	572	545	-2	328	402	-25	900	947	-12
1971/72	459	511	-21	376	395	-14	835	905	-18
1972/73	455	486	-22	386	380	-12	841	865	-17
1973/74	556	513	-5	326	366	-25	882	879	-13
1974/75	585	525	0	393	362	-10	978	887	-4
1975/76	528	517	-9	321	360	-27	849	877	-17
1976/77	598	544	3	400	365	-8	998	910	-2
1977/78	701	594	20	418	372	-4	1119	965	10
1978/79	547	592	-6	422	391	-3	969	983	-5
1979/80	689	613	18	439	400	0	1128	1013	11
1980/81	720	651	24	552	446	26	1272	1097	25
1981/82	637	659	9	427	452	-2	1064	1110	4
1982/83	766	672	32	378	444	-13	1144	1115	12
1983/84	649	692	11	222	404	-49	871	1096	-15
1984/85	619	678	6	728	461	67	1347	1140	32
1985/86	577	650	-1	441	439	1	1018	1089	0
1986/87	785	679	35	475	449	9	1260	1128	24
1987/88	700	666	20	507	475	16	1207	1141	18
1988/89	779	692	34	367	504	-16	1146	1196	12
1989/90	816	731	40	394	437	-10	1210	1168	19
1990/91	664	749	14	440	437	1	1104	1185	8
1991/92	770	746	32	526	447	20	1296	1193	27
1992/93									
μ	582.5			436.9			1019.4		
SD	116.5			84.3			145.6		
CV	20.0			19.3			14.3		
skew	0.0			0.6			0.3		
min	346.0			222.0			668.0		
Q1	507.8			385.5			932.5		
Me	581.0			428.5			987.5		
Q2	653.5			484.0			1120.8		
max	816.0			728.0			1347.0		

Station XIV (Stronachlachar):

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1914/15				525.8		-36.7			
1915/16	1187.5		-10.2	622.3		-25.1	1809.8		-16.1
1916/17	1102.4		-16.6	744.2		-10.4	1846.6		-14.4
1917/18	1496.1		13.2	708.7		-14.7	2204.7		2.2
1918/19	1258.6		-4.8	668.0	653.8	-19.6	1926.6		-10.7
1919/20	1638.3	1336.5	23.9	868.7	722.4	4.6	2507.0	2058.9	16.3
1920/21	1550.7	1409.2	17.3	685.8	735.1	-17.4	2236.5	2144.3	3.7
1921/22	1351.3	1459.0	2.2	769.6	740.2	-7.3	2120.9	2199.1	-1.6
1922/23	1239.5	1407.7	-6.2	1061.7	810.8	27.9	2301.2	2218.4	6.7
1923/24	995.7	1355.1	-24.7	965.2	870.2	16.2	1960.9	2225.3	-9.1
1924/25	1219.2	1271.3	-7.8	872.5	871.0	5.1	2091.7	2142.2	-3.0
1925/26	1364.0	1233.9	3.2	779.8	889.8	-6.1	2143.8	2123.7	-0.6
1926/27	1315.7	1226.8	-0.5	965.2	928.9	16.2	2280.9	2155.7	5.8
1927/28	1731.0	1325.1	30.9	913.1	899.2	10.0	2644.1	2224.3	22.6

Year	Oct-Mar	mov. av.	% of mean	Apr-Sep	mov. av.	% of mean	Annual	mov. av.	% of mean
1928/29	1174.8	1360.9	-11.1	901.7	886.5	8.6	2076.5	2247.4	-3.7
1929/30	1656.1	1448.3	25.3	745.5	861.1	-10.2	2401.6	2309.4	11.4
1930/31	1350.0	1445.5	2.1	787.4	862.6	-5.2	2137.4	2308.1	-0.9
1931/32	1416.1	1465.6	7.1	848.4	839.2	2.2	2264.4	2304.8	5.0
1932/33	1647.2	1448.8	24.6	673.1	791.2	-18.9	2320.3	2240.0	7.6
1933/34	891.5	1392.2	-32.6	891.5	789.2	7.4	1783.1	2181.4	-17.3
1934/35	1402.1	1341.4	6.1	800.1	800.1	-3.6	2202.2	2141.5	2.1
1935/36	1177.3	1306.8	-11.0	679.5	778.5	-18.2	1856.7	2085.3	-13.9
1936/37	1464.3	1316.5	10.8	797.6	768.4	-4.0	2261.9	2084.8	4.9
1937/38	1172.2	1221.5	-11.3	894.1	812.5	7.7	2066.3	2034.0	-4.2
1938/39	1811.0	1405.4	37.0	702.3	774.7	-15.4	2513.3	2180.1	16.6
1939/40	994.4	1323.8	-24.8	584.2	731.5	-29.6	1578.6	2055.4	-26.8
1940/41	1179.8	1324.4	-10.8	557.5	707.1	-32.9	1737.4	2031.5	-19.4
1941/42	1074.4	1246.4	-18.7	1053.3	758.3	26.9	2127.8	2004.7	-1.3
1942/43	1532.6	1318.5	15.9	1057.9	791.1	27.4	2590.5	2109.5	20.1
1943/44	1179.8	1192.2	-10.8	879.3	826.5	5.9	2059.2	2018.7	-4.5
1944/45	1471.4	1287.6	11.3	956.1	900.8	15.1	2427.5	2188.5	12.6
1945/46	1129.3	1277.5	-14.6	829.6	955.2	-0.1	1958.8	2232.8	-9.2
1946/47	952.8	1253.2	-27.9	962.9	937.2	16.0	1915.7	2190.3	-11.2
1947/48	1240.5	1194.8	-6.2	1103.9	946.4	32.9	2344.4	2141.1	8.7
1948/49	1440.9	1247.0	9.0	726.7	915.8	-12.5	2167.6	2162.8	0.5
1949/50	1463.3	1245.4	10.7	1174.2	959.5	41.4	2637.5	2204.8	22.3
1950/51	907.8	1201.1	-31.3	741.2	941.8	-10.7	1649.0	2142.8	-23.5
1951/52	1178.1	1246.1	-10.9	654.3	880.1	-21.2	1832.4	2126.2	-15.0
1952/53	826.5	1163.3	-37.5	913.4	842.0	10.0	1739.9	2005.3	-19.3
1953/54	1343.2	1143.8	1.6	890.0	874.6	7.2	2233.2	2018.4	3.6
1954/55	1432.3	1137.6	8.3	619.3	763.6	-25.4	2051.6	1901.2	-4.9
1955/56	993.1	1154.6	-24.9	888.7	793.1	7.0	1881.9	1947.8	-12.7
1956/57	1396.2	1198.3	5.6	740.4	810.4	-10.8	2136.6	2008.6	-0.9
1957/58	1124.5	1257.9	-14.9	882.9	804.3	6.3	2007.4	2062.1	-6.9
1958/59	932.2	1175.7	-29.5	713.2	768.9	-14.1	1645.4	1944.6	-23.7
1959/60	1355.3	1160.3	2.5	876.8	820.4	5.6	2232.2	1980.7	3.5
1960/61	1404.9	1242.6	6.3	1130.8	868.8	36.2	2535.7	2111.5	17.6
1961/62	1419.4	1247.2	7.4	1010.2	922.8	21.7	2429.5	2170.0	12.7
1962/63	883.4	1199.0	-33.2	881.6	922.5	6.2	1765.0	2121.6	-18.1
1963/64	909.8	1194.6	-31.2	989.1	977.7	19.1	1898.9	2172.3	-11.9
1964/65	1038.4	1131.2	-21.5	1084.8	1019.3	30.6	2123.2	2150.5	-1.5
1965/66	1285.0	1107.2	-2.8	749.6	943.1	-9.7	2034.5	2050.2	-5.7
1966/67	1499.1	1123.1	13.4	884.2	917.9	6.5	2383.3	2041.0	10.5
1967/68	1172.0	1180.8	-11.4	701.0	881.7	-15.6	1873.0	2062.6	-13.1
1968/69	880.4	1175.0	-33.4	773.2	838.6	-6.9	1653.5	2013.5	-23.3
1969/70	1160.8	1199.4	-12.2	961.1	813.8	15.7	2121.9	2013.3	-1.6
1970/71	1320.4	1206.5	-0.1	632.5	790.4	-23.8	1952.9	1996.9	-9.4
1971/72	1225.7	1151.8	-7.3	861.8	785.9	3.8	2087.5	1937.8	-3.2
1972/73	1115.2	1140.5	-15.6	806.6	807.0	-2.9	1921.8	1947.5	-10.9
1973/74	1490.5	1262.5	12.7	709.2	794.2	-14.6	2199.7	2056.8	2.0
1974/75	1554.7	1341.3	17.6	700.6	742.1	-15.6	2255.3	2083.4	4.6
1975/76	1272.2	1331.7	-3.8	689.2	753.5	-17.0	1961.4	2085.1	-9.0
1976/77	1303.0	1347.1	-1.4	806.5	742.4	-2.9	2109.5	2089.5	-2.2
1977/78	1412.8	1406.6	6.9	631.1	707.3	-24.0	2043.9	2114.0	-5.2
1978/79	1234.6	1355.5	-6.6	778.1	721.1	-6.3	2012.7	2076.6	-6.7
1979/80	1364.4	1317.4	3.2	850.4	751.1	2.4	2214.8	2068.5	2.7
1980/81	1492.5	1361.5	12.9	789.9	771.2	-4.9	2282.4	2132.7	5.8
1981/82	1488.2	1398.5	12.6	901.4	790.2	8.6	2389.6	2188.7	10.8
1982/83	1704.3	1456.8	28.9	673.0	798.6	-19.0	2377.3	2255.4	10.2
1983/84	1504.8	1510.8	13.8	541.4	751.2	-34.8	2046.2	2262.1	-5.1
1984/85	1315.1	1501.0	-0.5	1349.2	851.0	62.5	2664.3	2352.0	23.6
1985/86	1421.6	1486.8	7.5	836.8	860.4	0.8	2258.4	2347.2	4.7
1986/87	1675.1	1524.2	26.7	751.5	830.4	-9.5	2426.6	2354.6	12.5
1987/88	1581.7	1499.7	19.6	1038.0	903.4	25.0	2619.7	2403.0	21.5
1988/89	1776.8	1554.1	34.4	791.5	953.4	-4.7	2568.3	2507.5	19.1
1989/90	2063.7	1703.8	56.1	746.3	832.8	-10.1	2810.0	2536.6	30.3
1990/91	1331.6	1685.8	0.7	878.9	841.2	5.8	2210.5	2527.0	2.5
1991/92	1736.6	1698.1	31.4	1161.7	923.3	39.9	2898.3	2621.4	34.4
1992/93									
μ	1322.1			830.4			2156.4		
SD	251.2			159.2			284.1		
CV	19.0			19.2			13.2		
skew	0.2			0.6			0.3		
min	826.5			525.8			1578.6		
Q1	1172.2			710.2			1958.8		
Me	1331.6			806.6			2136.6		
Q2	1488.2			901.6			2320.3		
max	2063.7			1349.2			2898.3		