Addis Ababa University
Addis Ababa Institute of Technology
School of Graduate Studies

Estimation of Probable Maximum Precipitation (PMP) Using In-Situ and Reanalysis Global Precipitation Products

(A CASE STUDY ON UAPPER BLUE NILE BASIN (UBNB))

A thesis submitted and presented to the school of graduate studies of Addis Ababa University in partial fulfillment of the degree of Masters of Science in Civil and Environmental Engineering (Major Hydraulic Engineering)

BY

Abenezer Endale

Advisor: Dr. Semu Ayalew

Co-Advisor: Dr.Ing. Dereje Hailu

Addis Ababa University

Ethiopia

June, 2016

Addis Ababa University
Addis Ababa Institute of Technology
School of Graduate Studies

Estimation of Probable Maximum Precipitation (PMP) Using In-Situ and Reanalysis Global Precipitation Products

(A CASE STUDY ON UAPPER BLUE NILE BASIN (UBNB))

A thesis submitted and presented to the school of graduate studies of Addis Ababa University in partial fulfillment of the degree of Masters of Science in Civil and Environmental Engineering (Major Hydraulic Engineering)

BY

Abenezer Endale

Approval by Board of Examiners

----------	----------
Advisor	Signature
----------	----------
Internal Examiner	Signature
----------	----------
External Examiner	Signature
----------	----------
Chairman (Department of Graduate Committee)	Signature

CERTIFICATION

The undersigned certify that he has read the Thesis entitled Estimation Probable Maximum Precipitation (PMP) Using In-Situ and Reanalysis Global Precipitation Products (A Case Study On Upper Blue Nile Basin (UBNB)) and hereby recommend for acceptance by the Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science.

……...

Dr.Ing. Dereje Hailu

(Supervisor)

……

Date

DECLARATION AND COPY RIGHT

I, Abenezer Endale Baheru , declare that this is my own original work and that it has not been presented and will not be presented to any other University for similar or any degree award.

Signature_____

Date_____

Abenezer Endale
abeniug2001@gmail.com
Pho.No.+251913638791
June, 2016

ACKNOWELEDGEMENT

Beyond all, I would like to give a glory to the almighty God for his giving abundant life and grace through Christ Jesus in the enlightenment of Holy Spirit to did my thesis properly.

I would like to express my genuine gratitude and appreciation to Dr Semu Ayalew, and Dr.Ing. Dereje Hailu for their encouragement, guidance and support from the initial to the final level of this thesis.

I would like to say a special thank for EartH2Observe project for their technical and financial support.

I would like to deliver a special thank for Mr. Dejene Sahlu, for his providing the reanalysis data who is currently a PhD candidate in Ethiopian Institute of Water Resources (EIWR).

I also acknowledge, National Meteorological Service Agency, who supplied me in-situ rainfall data free of charge.

I would like to say thanks my big sis and class met Kidist Demessie for her mapping contours of the result using GIS software.

I am very grateful to Addis Ababa Institute of Technology, Department of Civil & Environmental Engineering for allowing me to take part in the Master Program.

Finally, I would like to express my warm feeling of appreciation and tank to my friends who helped me in all stages especially to Miretu Abirham, Birhan Tekiwam, Selamawit Hafitu and all class met of Hydraulic Engineering who were spiritually with me, and gave me the strength to finalize my duties successfully. Thanks for your encouragement and true friendship! Your friendship meant a great deal to me.

Abenezer Endale

abeniug2001@gmail.com

Pho.No.+251913638791

June, 2016

DEDICATION

Dedicated to Mission for Nation International Church and my beloved family.

ABSTRACT

Probable Maximum Precipitation (PMP) is defined as theoretically the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a particular time of year. The PMP for rainfall stations in Ethiopia have been estimated by Hershfield statistical method with frequency factor (K) determined by the Hershfield's chart. But the chart was originally developed by using over 2,700 metrological stations ninety percent of which were taken from USA which might not give reliable estimates for a country like Ethiopia having different climatic conditions with that of USA. Therefore, the objective of this study was to evaluate the frequency factor obtained from the Hershfield's chart and to provide fresh and reliable estimates of PMP using in-situ and ECMWF, ECMWF bias corrected & GLADS reanalysis global precipitation products for UBNB and then evaluate PMP value of reanalysis global precipitation products with the in situ PMP value. The study shows both in-situ and reanalysis products for 1 day, 2 & 3 days the K_m and PMP (mm) value are not more than 11 and 875 respectively and GLADS precipitation product is adequately capture PMP with respective to the in situ PMP result, and both ECMWF & ECMWF bias corrected reanalysis precipitation products are inadequate to capture PMP value under this study area. Therefore, for ECMWF and ECMWF bias corrected reanalysis precipitation product required data down scaling or other major data improvement technique to capture PMP value adequately. Whereas, the computed PMP value as a sub basin of UBNB are shown, three of them of the reanalysis products are not adequately captured the PMP value with respective to the in-situ PMP value, so, the reanalysis products as sub basin of UBNB are not practicable it needs minor and major data improvement techniques. In UBNB also comparison of the PMP value using the new K_m and the chart values for both in situ and reanalysis products exhibited difference 38 up to 96.4%, this result confirmed the Hershfield's chart overestimated PMP value which leads to uneconomical designs. The average ratio of the PMP to the 10,000 years return period quantiles for in situ, ECMWF, ECMWF bias Corrected and GLADS precipitation product for study area was found to be about 1.7,1.6,1.8 and 1.3 respectively. this shows ECMWF, ECMWF bias corrected and GLADS products are adequately captured the result of average ratio value of the in situ data.

<u>KEY WORDS:</u> PROBABLE MAXIMUM PRECIPITATION, UPPER BLUE NILE BASIN, HERSHFIELD STATISTICAL METHOD, and REANALYSIS GLOBAL PRECIPITATION PRODUCTS.

Table of Contents Page

CERTIFICATION ii
DECLARATION AND COPY RIGHT iii
ACKNOWELEDGEMENT iv
DEDICATION v
ABSTRACT vi
LIST OF TABLE x
LIST OF FIGURE xi
LIST OF TABLES and FIGURE IN THE APPENDIX xii
LIST OF ABBREVIATIONS AND ACRONYM xiii
1.0 INTRODUCTION AND BACKGROUND 1
1.1 Introduction 1
1.2 Description of the Study Area 2
1.3 Climate and Rainfall Pattern of the Study Area 3
1.4 Problem Description 4
1.5 Objectives of the Study 5
1.5.1 General Objective 5
1.5.2 Specific Objective of the Study 5
1.6 Research Question 6
1.7 Significance of the study 6
2.0 LITERATURE REVIEW 7
2.1 Probable maximum precipitation (PMP) 7
2.1.1 Application of PMP in Spillway Design 7
2.1.2 Maximum Observed Point Rainfalls 8
2.1.3 International research for Estimating Extreme Precipitation 9
2.1.4 Previous Studies and Application Trend in the Country 12
2.1.5 World Meteorological Organization (WMO) Guidelines 13
2.2 Reanalysis Global Precipitation Product 14
2.2.1 European Centre for Medium-Range Weather Forecasts (ECMWF) 15
2.2.2 Global Land Data Assimilation System (GLDAS) 17
3.0 METHODOLOGY 20
3.1 A Criteria for Selecting Statistical Method 20

3.1.1 Statistical Approach 20
3.1.2 Physical Approach 20
3.1.3 Empirical Approach 21
3.2 Probable Maximum Precipitation (PMP) by Statistical Methods 22
3.2.1 Procedure of New Km Development 24
3.2.2 Adjustment of Mean and Standard deviation for Maximum Observed Events 25
3.2.3 Adjustment of Mean and Standard Deviation for Sample Size 27
3.2.4 Adjustment of Data for Fixed Observational Time Intervals 28
3.2.5 Transformation of Point PMP to Areal PMP 29
3.3 Frequency Distribution and Analysis 30
3.3.1 Hydrologic Frequency Analysis 30
3.3.2 Moments of Distributions 32
3.3.3 Method of Parameter Estimation 34
3.3.4 Selection of Parameters and Quantile Estimation 36
4.0 DATA AVAILABLITY AND ANALYSIS 37
4.1 Rainfall Data Source 37
4.2 Data Availability 37
4.2.1 Gauge Stations for the Respective Sub Basin of UBNB 39
4.3 Data Quality Control 40
4.3.1 Checking of Reanalysis Precipitation Product with the In-Situ Data 40
4.3.2 Testing for Outliers 42
4.3.3 Test for Independence 43
4.3.4 Homogeneity Test for the Data Series 44
5.0 RESULTS AND DISCUSSION 47
5.1 The Rainfall Frequency Analysis 47
5.1.1 Selection and Evaluation of Parent Distributions for the Rainfall Data 47
5.1.2 Parameters Selection and Quantile Estimation 50
5.2 Probable Maximum Precipitation (PMP) 53
5.2.1 Determination of Frequency Factor (K) Values Using Hershfield's Frequency Equation for UBNB 53
5.2.2 Evaluating the Frequency factor (K) Values of the reanalysis products for a sub basin of UBNB 56
5.2.3 Computed Maximum Frequency Factor (Km) Values Using Hershfield's Frequency Equation for a Sub Basin of UBNB. 58
5.2.4 Determination of Frequency Factor (K) Values Using Hershfield's Chart. 59

5.2.5 Comparison of the frequency factor (K) Values using Hershfield's frequency equation and Hershfield's Chart. 59
5.2.6 Estimation of PMP Using Hershfield's Frequency Equation for the Upper Blue Nile Basin 61
5.2.7 Estimation of PMP Using Hershfield's Chart and Compering the Result with the computed PMP of Hershfield's Frequency Equation. 64
5.2.8 Comparing the PMP Values with the 10,000 years Return Period Quantiles in the Study Area 68
5.2.9 Comparing the PMP values of Some of Previous Dam Design Trend in UBNB with this Study Results 69
5.3 Construction of k and PMP Contour Maps for UBNB 70
6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS 75
6.1 Summary and Conclusion 75
6.2 Recommendations 77
7.0 REFERENCES 78
APPENDIXES 81
APPENDIX A: Available Meteorological Stations Used for Upper Blue Nail Basin 81
APPENDIX B: Available in Situ and Reanalysis Data for 1 day, 2 and 3 days' durations 84
APPENDIX C: Data Test Results for One Day Durations of in Situ Data 175
APPENDIX D: Mathematical Expressions for Statistical Distributions of Annual Maximum Series 177
APPENDIX E: Estimated Rainfall Depths for in situ and Reanalysis Data for Different Return Periods 179
APPENDIX F: Frequency Factor K Values for in situ and Reanalysis Data 203
APPENDIX G: Probable Maximum Precipitations (PMP) of Different Stations in the UBNB and the Ratios of PMP to 10,000 Years Return Period Quantiles for in situ and Reanalysis data.. 207
APPENDIX H: K and PMP contour Maps of UBNB 217

LIST OF TABLE

Table 2-1 World's greatest observed point rainfall 9
Table 2-3 The ratios of the PMPs to the 10,000 Years events for the stations used..... 12
Table 2-4 Basic characteristics of the GLDAS data 19
Table 4.1 Summary of meteorological networks in Upper Blue Nile Basin 40
Table 4-2 Outliers Test for Wegel Tena Station..... 43
Table 4-3 Homogeneity test result of Wegel Tena station for 1-day in-situ data..... 45
Table 5 -1 Candidate distributions for Finoteselam station 49
Table 5-2 Standard Error of different parameter estimation Methods for the best fitted distributions..... 50
Table 5-3 Best Fitted distributions and method of parameter estimation..... 51
Table 5-4 Estimated Quantiles of different durations for finoteselam station..... 52
Table 5-5 shows the k value for in-situ 1-day duration at finoteselam station. 53
Table 5-6 The frequency factor K values for in-situ 1-day duration of the meteorological stations in the Upper Blue Nile Basin 54
Table 5-7 Number of stations for the given k value range for a 1-day duration of UBNB 55
Table 5-8 Number of stations for the given k value range for a sub basin of UBNB..... 56
Table 5-9 Frequency factor (Km) Values for a sub basin of UBNB using Hershfield's Frequency Equation. 58
Table 5-10: Frequency Factors for some of the stations in the basin having statistical values fitting Pearson (III) distribution. 61
Table 5-11 Procedure for PMP estimation at Finoteselam station for in-situ 1-day durations..... 62
Table 5-12 Km and PMP Result for In-Situ and Reanalysis Data..... 63
Table 5-13 PMP Values for a sub basin of UBNB using Hershfield's Frequency Equation. 64
Table 5-14 Comparison of the resulted PMP with the PMPs from the graphical method..... 65
Table 5-15 Comparison of the resulted PMP with the PMPs from the graphical method for 1-day in situ and reanalysis data. 68
Table 5-16 The ratio of PMP to the 10,000 years return period event 69
Table 5-17 Compering PMP value of the previous dam design trend with this study result. 70

LIST OF FIGURE

Figure 1-1 Upper Blue Nile Basin 3
Figure 3-1 The Hershfield's chart **for** determination of frequency factor Km 23
Figure 3-2 Adjustment of mean of annual series for maximum observed rainfall (Hershfield, 1961b) 26
Figure 3-3 Adjustment of standard deviation of annual series for maximum observed Rainfall (Hershfield, 1961b) 27
Figure 3-4 Adjustment of mean and standard deviation of annual series for length of record (Hershfield, 1961b) 28
Figure 3-5 Depth area reduction curve 30
Figure 4 -1 Distribution of Rainfall stations over Upper Blue Nile Basins……...38
Figure 4 -2 station distribution on 0.25-degree grid box of GLADS ……....39
Figure 4-3 the scatter graph In-situ with ECMWF Product. 41
Figure 4-4 the scatter graph In-situ with ECMWF bias Corrected Product. 41
Figure 4-5 the scatter graph In-situ with GLADS Product. 42
Figure 5-1: MRD for 1-day in-situ rainfall depth at Finoteselam station 48
Figure 5-2: L-MRD for 1-day in-situ rainfall depth at Finoteselam station 49
Figure 5-3 Frequency factor (K) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's frequency equation 71
Figure 5-4 PMP (mm) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's frequency equation 72
Figure 5-5 Frequency factor (K) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's Chart. 73
Figure 5-6 PMP (mm) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's Chart. 74

LIST of TABLES and FIGURE in the APPENDIX

Table B.1 Annual Maximum Rainfall of in-situ data for Different Stations in UBNB (mm)... 84

Table B.2 Approximate longitude & latitude for the available stations in UBNB from the grid longitude & latitude of the reanalysis data 128

Table B.3 Annual Maximum Rainfall of ECMWF for 0.5 by 0.5 grid Size (mm)..... 131

Table B.4 Annual Maximum Rainfall of ECWMF-With Bias Corrected for 0.5 by 0.5 grid Size (mm)…….144

Table B.5 Annual Maximum Rainfall of GLADS for 0.25 by 0.25 grid Size (mm)..... 156

Table G.1 Probable Maximum Precipitations (PMP) of different stations in the UBNB and the ratios of PMP to 10,000 years return period quantiles for 1-day. 207

Table G.2 Probable Maximum Precipitations (PMP) of different stations in the UBNB and the ratios of PMP to 10,000 years return period quantiles for 2-day..... 210

Table G.3 Probable Maximum Precipitations (PMP) of different stations in the UBNB and the ratios of PMP to 10,000 years return period quantiles for 3-day..... 214

Figure H1. Frequency factor (K) Contour Maps of UBNB for both in-situ and reanalysis products using Hershfield's frequency equation..... 217

Figure H2. PMP (mm) Contour Maps of UBNB for both in-situ and reanalysis products using Hershfield's frequency equation 219

Figure H3. Frequency factor (K) Contour Maps of UBNB both in-situ and reanalysis products using Hershfield's Chart. 222

Figure H4. PMP (mm) Contour Maps of UBNB reanalysis products using Hershfield's Chart.224

LIST OF ABBREVIATIONS AND ACRONYM

AM	Annual Maximum
BNRB	Blue Nile River Basin
Cs	Coefficient of skewness
Cv	Coefficient of Variation
ECMWF	European Centre for Medium-Range Weather Forecasts
EV1	Extreme Value 1
EXP	Exponential
G.Patrio	General Patrio
GEV	Generalized Extreme Value
GLDAS	Global Land Data Assimilation System
HDISC	Hydrology Data and Information Services Center
IDW	Inverse Distance Weighting
K	Frequency factor
Km	maximum Frequency factor
LLG	Log Logistic
LMRD	L-Moment Ratio Diagram
LN3	Log Normal 3
Masl	Mean above sea level
ML	Maximum Likelihood
MOM	Method of Moment
MoWR	Ministry of Water Resource
MRD	Moment Ratio Diagram
NASA	National Aeronautics and Space Administration
NMSA	National Meteorological Service Agency
NOR	Normal
NRC	National Research Council
NWP	Numerical weather prediction
P III	Pearson 3
PMF	Probable Maximum Flood

PMP	Probable Maximum Precipitation
PWM	Probability Weighted Moment
T	Return Period
UBNB.	Upper Blue Nile basin
WMO	World Meteorological Organization

1.0 INTRODUCTION AND BACKGROUND

1.1 Introduction

The Probable Maximum Flood (PMF) is one of the ranges of conceptual flood events used in the design of hydrological structures to protect the structures from overtopping and against damage. It is computed from the Maximum Probable Precipitation (PMP) that is possible in the catchments. According to the world meteorological organization definition (WMO, 2009), the Probable Maximum Precipitation (PMP) is defined as theoretically the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a particular time of year. This PMP magnitude together with its spatial and temporal distributions of occurrence can be used to estimate the PMF at the dam site.

The practice of design of dam spillways in Ethiopia is widely employed using the value of probable maximum flood (PMF) obtained from PMP. Apart from being extremely large flood magnitude, the procedure adapted in the country is based on graphical Herschfield's estimation procedure (WMO, 1986, No.332) which is not developed or adapted to the country. As a result, the cost of dam construction in the country is high due to extremely high cost of spillway. This shows discourages the planning and construction of dam facilities in the country for alleviating poverty and food security. Therefore, the purpose of this study focuses on evaluation of the frequency factor (Km) embedded in Hershfield's frequency equation of PMP using historical daily rainfall (in situ data) and reanalysis global precipitation products and refine Km values that would adequately represent the Upper Blue Nile basin (UBNB).

The procedure given by Hershfield,1961 will be used to develop the new Km and the results compare with existing working elsewhere.

A re-analysis of global precipitation product where new retrieval techniques and sensors would be evaluated for use in global precipitation estimates along with higher space and time resolution data. due to such reasons it is useful to estimate Km and PMP for UBNB using the reanalysis global precipitation products. For this study select the two popular precipitation products, these are European Centre for Medium-Range Weather Forecasts (ECMWF) and Global Land Data Assimilation System (GLDAS).

1.2 Description of the Study Area

The Upper Blue Nile originates in the highlands of Ethiopia and Eretria, as do the other major tributaries of the Nile, the Atbara and the Sobat. About 85% of the Nile's waters originate in Ethiopia and Eretria, while the majority of the river's water is used in the Sudan and Egypt.

The Abbay River basin lies in the west of Ethiopia between 7 ° 45` and 12 ° 45` N, and 34 ° 05` and 39 ° 45` E. It drains towards Sudan on its western border and shares common boundaries with the Tekeze basin to the north, the Awash basin to the east and southeast, the Omo-Ghibe basin to the south, and Baro-Akobo basin to the west. The total area of the basin is 199,812 km^2 including Lake Tana which has an area of about 4,070 km2. About 46, 31 and 23% of the total basin area falls in Amhara, Oromiya and Benishangul-Gumuz respectively. The population of the basin is about 14.23 million out of which about 64%, 33% and 3% are in Amhara, Oromiya and Benshangul-Gumuz respectively. The population percentage of urban areas is about 9.3%.

Physiographical the basin is dominated by part of the western highland plateau of Ethiopia tilting gently westwards from the rift valley that splits it from the eastern plateau. Generally, about two-third of the basin area falls in the highlands above 1,500 masl altitude rising to over 4,000 masl. (MoWR).

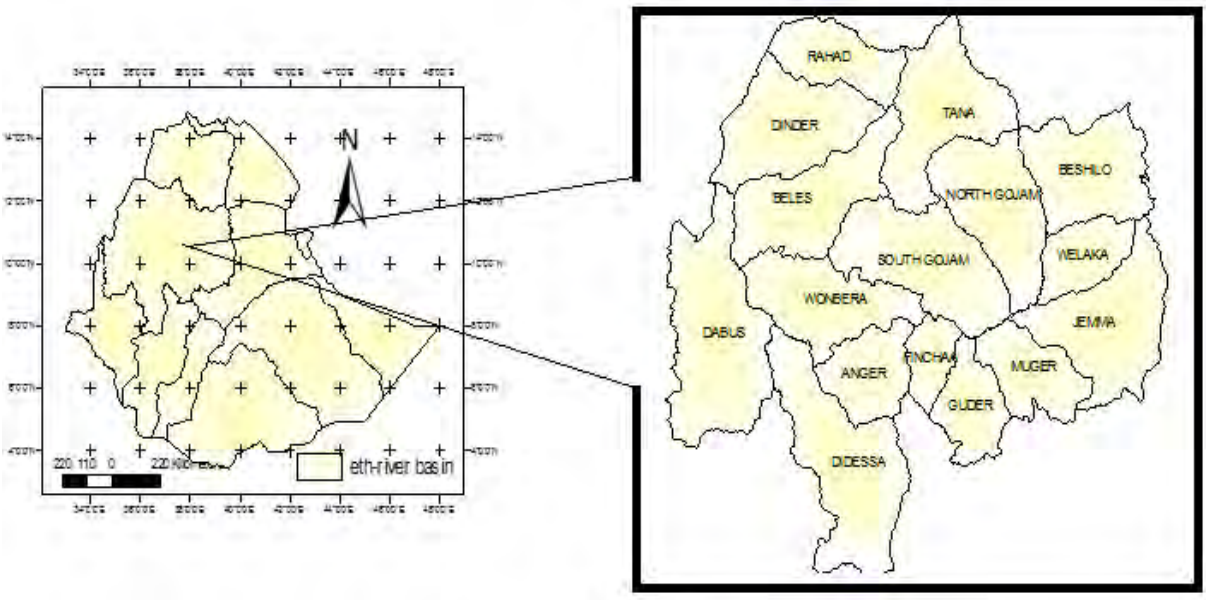


Figure 1-1 Upper Blue Nile Basin

1.3 Climate and Rainfall Pattern of the Study Area

The climate of Upper Blue Nile basin/UBNB/ is dominated by two factors; its near-equatorial location and altitude. The influence of these factors determines the rich variety of local climates ranging from hot and desert-like along the Sudan border to temperate on the high plateau and cold on the mountain peaks. Annual rainfall varies between 800 to 2,200 mm with a mean value of about 1,420 mm. The mean temperature of the basin is 18.5 ° C with a minimum and maximum average daily temperature of 11.4 and 25.5 ° C respectively. Accordingly, the basin exhibits two main agro-ecology zones namely highland with altitudes above 1500 masl and lowlands below 1500 masl.

There are three recognized seasons, the main Rainy season (kiremt) lasts generally from June to September during which south west winds bring rains from Atlantic Ocean, about 70-90% of total Rainfall occurs during this season. A dry season (Bega) lasts from October to January during which clear skies are associated with maximum sun shine and low relative humidity. Finally, the minor rainy season (Belg) lasts from February to May during which south-East winds

bring the small rains from the Indian ocean and temperatures are at their highest level. The timing and duration of these seasons varies considerably by location. Spatial characteristics combine with these seasonal characteristics to define the pattern of the climate in different areas.

Four readily-identified areas can be described according to their climatic conditions, two with relatively high rainfall and two with relatively low rainfall. These are: -

- A southern area covering much of east and west Wellega, Jimma and Illubabor Zone (Region 4)
- A central area covering most of west Gojam and Agew Awe (Region 3) as well as part of the neighboring zones of region 3 & 6.
- An area covering most of eastern part of the basin, including North and south Wello, eastern part of Eastern. Gojam and south Gondar (all in region 3) and much of North and NW. Shewa (Region 4), but excluding small areas in the mountains, and
- A west and north west area covering north Gondar in Region3 and much of (Region 6)

1.4 Problem Description

Due to lack of properly established probable maximum flood (PMF) procedure, professionals and practitioners alike tend to use the Hershfield's graphical procedure to estimating the PMP and convert it into PMF. This method apparently is not well tested in the country and created heightened concern and debate. According to some research outputs in China, Romania (M.N. Desa et al. (2003) and P.R. Rakhecha) and other countries, the graphical procedure was found to overestimate the actual values. Therefore, the purpose of this study focuses on evaluation of the frequency factor (Km) embedded in Hershfield's frequency equation of PMP using historical daily rainfall (in situ data) and reanalysis global precipitation products and refine Km values that would adequately represent the

Upper Blue Nile basin (UBNB) and on estimation of reliable PMP values of the stations in the basin for 1 day, 2 and 3 days' durations.

The procedure given by Hershfield, D. M., 1965 will be used to develop the new Km and the results are compared with the existing works made elsewhere.

1.5 Objectives of the Study

1.5.1 General Objective

The overall objective of this study is to develop Regionalized probable maximum precipitation (PMP) for Probable Maximum Flood (PMF) development and application in design flood hydrograph.

1.5.2 Specific Objective of the Study

- To evaluate the frequency factor (Km) embedded in Hershfield's frequency equation for UBNB using in-situ and ECMWF, ECMWF bias corrected & GLADS reanalysis global precipitation products.
- To compare the frequency factor (Km) result in Hershfield's frequency equation with the values obtained from the Hershfield's chart.
- To provide fresh and reliable estimates of PMP in UBNB using upper mentioned frequency factor for both the in-situ and reanalysis precipitation product.
- To Compute the maximum rainfall depths (Quantiles) for different return periods.
- To Compute the ratio of probable maximum precipitation (PMP) values with the 10,000 years return period Quantiles for different durations.
- To evaluate the Km, PMP and the upper mentioned ratio values of ECMWF, ECMWF bias corrected & GLADS products from the respective in situ results.
- To produce K and PMP maps of the UBNB for both Hershfield's frequency equation and Hershfield's chart using GIS.

- ❖ To compare the PMP values of some of previous dam design trend in UBNB with this study results.

1.6 Research Question

- ➢ Does the reanalysis global precipitation product capture the PMP values adequately?
- ➢ Can we develop a better regionalized PMP maps assimilated from re-analysis and in-situ product?

1.7 Significance of the study

This paper will assist engineers and hydrologists in developing extreme flood estimates for major water resources engineering works and projects and to promote a relatively uniform approach to developing estimates of the Probable Maximum Flood (PMF) of very low probability for purposes of project design or evaluation, and to improve the consistency of estimates .Because deficiencies in PMP estimates result in similar deficiencies in PMF determination, a risk-based approach to hydraulic design criteria Engineers must often consider storm run-off when building a new structure. One of the steps in many hydrologic design projects is the determination of the rainfall events or events to be used.

The estimation of Probable Maximum Precipitation (PMP) for the basin is an important task for various engineering works such as spillway design for dams of the highest hazard category. It is therefore, anticipated that institutions and individuals involved in these sector will utilize the result of this study.

2.0 LITERATURE REVIEW

2.1 Probable maximum precipitation (PMP)

The PMP and PMF concepts were developed in the USA in the mid-twentieth century as a result of dissatisfaction with empirically or statistically based design flood estimates for major structures, and partly as a response to catastrophic failures. The concepts have since been adopted in many countries for high-hazard dams. Probable Maximum Precipitation (PMP) is defined by the World Meteorological Organization (WMO,2009 No 1045) as theoretically the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location at a certain time of year. The idea is that at a given location with a given climate, an upper bound to precipitation can be estimated by analyzing the meteorology of historic storms and maximizing the key causative factors.

Although the PMP has a theoretical exceedance probability of zero, meaning that it is so large that it will never be exceeded, this is not the case in reality. Consequently, a few studies have sought to assign a risk statement to PMP estimates. (NRC, 1994). Estimates of extreme floods have long been used to design the flood-handling facilities of major dams whose failure might cause loss of life or extensive property damage.

2.1.1 Application of PMP in Spillway Design

The hydrologic problem typically addressed in dam safety analysis is the determination of the capacity of the spillway needed to prevent catastrophic failure of the dam due to overtopping. The PMF is generally accepted as the design inflow for evaluating the spillway when there is potential loss of life due to dam failure in high hazard situations.

As per the first edition of Dam Safety Guidelines by the Canadian Dam Association (CDA 1999) dams are classified into four categories according to the perceived incremental consequences of failure these are very high, high, low and

very low dams. The criteria for the design flood as stated in CDA, 1999 are as follows.

- For very high dams: the PMF developed as a result of PMP is mandatory.
- For high dams: the design flood may be selected between the PMF and the 1000-years flood.
- For low dams: the design flood may be selected between the 1000-year and the 100-year floods.
- For very low dams the design flood selected is less than100-year floods.

The PMF represents an estimated upper bound on the maximum runoff potential for a particular watershed. In some sense, the inherent assumption is that a dam with a spillway designed to pass this flood has zero risk of overtopping.

2.1.2 Maximum Observed Point Rainfalls

Some of the largest point rainfalls for selected durations that have been observed are given in the following table. These values, which approach probable maximum precipitation magnitude, are enveloped by the approximate equation:

$$P = 422\ T^{0.475} \quad \text{(konrad ,1995)}$$

Where: P is rainfall in millimeters, and T is duration in hours

Table 2-1 World's greatest observed point rainfall

Duration	Depth (mm)	Location	Date
1 min	38	Barot, Guadeloupe	26 November 1970
1h00 min	401	Shangdi, Nei Monggol,	China 3 July 1975
6h	840	Muduocaidang,Nei Monggol, China	1 August 1977
24h	1825	Foc Foc, La Réunion	7-8 January 1966
2 days	2467	Aurere, La Réunion	7-9 April 1958
3 days	3130	Aurere, La Réunion	6-9 April 1958
7 days	5003	Commerson, La Réunion	21-27 January 1980
31 days	9300	Cherrapunji, India	1-31 July 1861
1 year	26461	Cherrapunji, India 1861	August 1860-July
2 years	40768	Cherrapunji, India	1860-1861

Revised: 29 November 1991, U.S.A. NWS; U.S.A. Bureau of Reclamation; Australian Bureau of Meteorology

2.1.3 International research for Estimating Extreme Precipitation

Svensson & Jones (2010a) carried out a review of rainfall frequency estimation methods, looking at methodologies currently applied in nine different countries

Table 2-2 Methodology for estimating extreme precipitation for nine countries.

Country	Description of methods
Sweden	The Swedish energy industry has developed procedures for dam design and safety (CMconsulting.no), including estimation of large return periods and PMP through the NERC method and areal reduction, as in Norway. At the Swedish Meteorological and Hydrological Institute (SMHI) estimation of extreme precipitation in points is performed by fitting observations of annual maxima to one of three distributions: Gumbel, GEV or GEV with constant theta (Wern & German, 2009). For areal precipitation a gridded data set is used and all grid points within a square of the respective area is analyzed (Asp, personal communication).
Denmark	Lundholm & Cappelen (2010) and Lundholm (2011) performed an analysis of extreme precipitation in Denmark for the periods 1961-2010 and 1874-2010, respectively. They use a peak-over-threshold (POT) method to estimate return periods at selected locations. Thresholds are chosen according to recommendations in Coles (2001) in order to find the smallest possible value that assures a Generalized Pareto Distribution (GPD). Thus all parameters of the extreme value distribution should be close to constant.
Finland	At the Finnish Meteorological institute (FMI) an analysis of 1, 5, and 14-day point and areal precipitation for areas of different sizes was performed, using observations of annual maxima from 1959-1998 and the Gumbel distribution (Solantie & Uusitalo, 2000; Veijalainen, 2011; Rissanen, 2011). Areal design precipitation totals were defined by two criteria; 1) the return period for the entire country should be more or equal to 50 years, and 2) the return period in the target region should be higher or equal to 10 000 years. The 10 000 year return values are used in dam safety in Finland.
Iceland	For estimation of extreme precipitation with defined return periods Elíasson (1999) apply the NERC M5 index parameter and an intensity-duration distribution function. A large scale M5 map was compiled for the entire country, while M5 maps in town planning scales were made available for populated areas using all precipitation information available in the area of interest. A generalized intensity-duration-frequency (IDF) relationship is suggested in Elíasson (1997): I = M5fTg(tr), where I is the intensity, fT is a function of the return period, and g(tr) is a function of the duration. The NERC method was earlier used in PMP estimation (Elíasson, 1991), however, due to lack of precipitation data, Elíasson (1997) suggested a different model for estimating PMP using a Gumbel distribution function on 24-hour precipitation annual maxima. The Icelandic Meteorological Office (IMO) recently produced a gridded dataset of daily precipitation with 1 km resolution using an orographic precipitation model (Crochet et al., 2007), which in the future will be applied in deriving statistics on extreme areal precipitation.

United Kingdom	The NERC method is used for return periods of 1000 years or longer. The FORGEX method (Reed et al., 1999) fitted to a depth-duration-frequency (DDF) model is applied for shorter return periods (Faulkner, 1999).
Ireland	Methodology for estimating point rainfall frequencies is described in Fitzgerald (2007). A Depth-Duration-Frequency (DDF) model is developed, consisting of an index rainfall value and a growth curve providing a multiplier of the index rainfall. The index rainfall is the median and the growth curve is the log-logistic distribution. Series of annual maxima are converted to sliding durations, and the DDF model is fitted to the series. Median rainfall and DDF parameters (with enforced consistency) are interpolated to a 2km grid using a kriging method, and return levels are estimated on the same grid
United States	An index flood approach, (e.g. Stedinger et al., 1993), is used with the mean annual maxima precipitation as index. Homogeneous regions are defined, and the most suitable probability distribution is selected for each region. L-moment statistics is applied to estimate growth curves, which are multiplied with the site index to obtain extreme precipitation estimates (Perica et al., n.d.).
Canada	Precipitation frequency analysis is performed using mean and standard deviation of annual maximum rainfall series, estimated from the method of moments, and a frequency-factor formulation of the Gumbel distribution. Gumbel parameters are presented in maps and updated IDF values for 549 points exist (Hogg et al., 1989; Hogg & Carr, 1985). PMP is estimated according to Hershfield (1977)
Australia	The 50-year precipitation is computed from a fitted Log-Pearson Type 3 distribution and used as index in the index-food method CRC-FORGE (Weinmann et al., 1999) which estimates return levels up to 2000 years. PMP is estimated from the 2000-year rainfall and is assigned a return period of 10 000 and 10 000 000 years, depending on area size. The growth curve is estimated from a version of the station-year approach to create a single long regional series

2.1.4 Previous Studies and Application Trend in the Country

The practice of design of dam spillways in Ethiopia is widely employed using the value of probable maximum flood (PMF) obtained from PMP. Apart from being extremely large flood magnitude, the procedure adapted in the country is based on graphical Herschfield's estimation procedure (WMO, 1986, No.332).

The final feasibility report taken from the ministry of water resources of the country entitled Lake Tana Sub-Basin Four Dams Project support the above idea they used the upper mentioned procedure for the design of Ribb and Megech dams. The PMPs of both dams were estimated using the Hershfield's graphical method for the durations of 24, 48 and 72 hours. The frequency analyses were also carried out in the report to obtain the 10,000 years return period rainfall events having the above mentioned durations. As per the results obtained in the report the ratios of the PMP values to the 10,000 years' rainfall events reach up to 3 times.

The following table shows the results of the studies for different stations around the dam sites.

Table 2-3 The ratios of the PMPs to the 10,000 Years events for the stations used

Station used for design of the dams	PMP Duration (hours)	PMP depth (mm)	The 10,000 years return period events (mm)	The ratios of PMP to 10,000 years events
Debre Tabor (for the Ribb dam design)	24	322	133	2.4
	48	347	166.8	2.1
	72	449	192.4	2.3
Gondar(for the Megech Dam design)	24	339	151	2.2
	48	476	181	2.6
	72	588	197	3.0

The above table shows that the established methodologies for PMP estimation in the country over estimate the PMP values. As a result, the cost of dam construction in the country is high due to high cost of spillway. Similar procedures have been taking place for other studies in the country.

2.1.5 World Meteorological Organization (WMO) Guidelines

According to "Manual on Estimation of Probable Maximum Precipitation (PMP)" (WMO, 2009), six methods of PMP estimation currently exist:

- **Local method:** The observed maximum storm is used to estimate PMP
- Transposition method: An extraordinary large storm close by is transposed to the watershed area.
- **Combination method:** Two or more storms in the area are combined to produce a sequence of artificial storms with long duration. This method can be applied in large watersheds and requires meteorological expertise
- **Inferential method:** A simplified physical equation describing the 3-D spatial structure of a storm is created. This method can be applied in medium to large watersheds and requires upper meteorological measurements in the area.
- **Generalized method:** Observed rainfall is separated into convergence and orographic rainfall in a large meteorologically homogeneous region. The method is time consuming and expensive and requires a large dataset of long-term rainfall measurements in the area. However, the results are likely to be of high accuracy.
- **Statistical method (proposed by Hershfield, USA):** The hydrological frequency analysis method is applied on data from several rain gauges, in combination with the regional generalized method. The area should be smaller than 1000km2 and meteorologically homogeneous.

For very large watersheds the following two methods are also applied:

- The major temporal and spatial combination method Hydro-meteorological methods are applied on the part of PMP that has the larger temporal and spatial influence on PMF, while the common correlation method and flood distribution method are applied on the part of PMP with smaller influence. The method combines temporal and spatial conditions.
- The storm simulation method based on historical floods Hydrological watershed models are applied in producing a storm with the potential to create an observed historical flood, and PMP is estimated by maximizing moisture.

In addition, a number of techniques for adjusting PMP estimates to orographic regions exist. In some cases, it is recommended to estimate areal precipitation using more than one method in order to obtain thorough hydrological estimates, especially in ungauged catchments like the mountain areas.

2.2 Reanalysis Global Precipitation Product

The reanalysis dataset is technology based which are used for data generation instead of observed data, when there is sparse of observed data. There are different types of dataset based on their area of application such as: Snow Cover (SC) used to generate the snow cover data, Global Runoff Data Centre (GRDC) for River mean daily Discharge Data, ECMWF Forcing for meteorological data, European Center for Medium-Range Weather Forecast (ECMWF) and Global Land Data Assimilation System (GLDAS) and etc. Each of the dataset including the datasets which are not explained are used as input and output data instead of observed data, when full and enough record length of observed data are not available.

Reanalysis makes use of data assimilation systems designed for weather forecasting. It uses a single model and analysis method for a consistent re-analysis of past observations.

2.2.1 European Centre for Medium-Range Weather Forecasts (ECMWF)

The European Centre for Medium-Range Weather Forecasts, ECMWF, is an independent intergovernmental organization supported by most of the nations of Europe and is based at Shinfield Park, Reading, United Kingdom. It operates one of the largest supercomputer complexes in Europe and the world's largest archive of numerical weather prediction data.

- **Background**: ECMWF was established in 1975, in recognition of the need to pool the scientific and technical resources of Europe's meteorological services and institutions for the production of weather forecasts for medium-range timescales (up to approximately two weeks) and of the economic and social benefits expected from it. members as of 2015 co-operation agreement It comprises 21 European countries:
  - the eighteen founding states of 1975: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Republic of Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom.
  - three states that joined since 2010: Iceland (April 2011), Slovenia (December 2012)[and Serbia (January 2015). It also has co-operation agreements with other states: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Israel, Latvia, Lithuania, Macedonia, Montenegro, Morocco, Romania and Slovakia. The Centre employs about 280 staff, mostly appointed from across the member states and co-operating states.
- **Objectives:** ECMWF aims to provide accurate medium-range global weather forecasts out to 15 days and seasonal forecasts out to 12 months. Its products are provided to the national weather services of its member states and co-operating states as a complement to their national short-range and climatological activities, and those national states use

ECMWF's products for their own national duties, in particular to give early warning of potentially damaging severe weather.

ECMWF's core mission is to:

- produce numerical weather forecasts and monitor the Earth-system;
- carry out scientific and technical research to improve forecast skill;
- maintain an archive of meteorological data.

To deliver this core mission, the Centre provides:

- twice-daily global numerical weather forecasts;
- air quality analysis;
- atmospheric composition monitoring;
- climate monitoring;
- ocean circulation analysis;
- hydrological prediction.

The Centre develops and operates global atmospheric models and data assimilation systems for the dynamics, thermodynamics and composition of the Earth's atmosphere and for interacting parts of the Earth-system. It uses numerical weather prediction methods to prepare forecasts and their initial conditions, and it contributes to monitoring the relevant parts of the Earth system.

- **Reanalysis:** ECMWF makes significant contributions to support research on climate variability, pioneering an approach known as reanalysis. This involves feeding weather observations collected over decades into a Numerical weather prediction (NWP) system to recreate past atmospheric, sea- and land-surface conditions over specific time periods to obtain a clearer picture of how the climate has changed. Reanalysis provides a four-dimensional picture of the atmosphere and effectively allows monitoring of the variability and change of global climate, thereby contributing also to the understanding and attribution of climate change. To date, and with support from Europe's National Meteorological Services

and the European Commission, ECMWF has conducted two major reanalysis of the global atmosphere: the first ECMWF re-analysis (ERA-15) project generated reanalysis from December 1978 to February 1994; the ERA-40 project generated reanalysis from September 1957 to August 2002.Over the past three decades ECMWF's wide-ranging programme of research has played a major role in developing such assimilation and modelling systems.[http://www.ecmwf.int/]

2.2.2 Global Land Data Assimilation System (GLDAS)

Global hydrological data such as soil moisture and evaporation are crucial for understanding the land surface process and the atmospheric general circulation modeling for climate simulation and weather forecasting. The Hydrologic Sciences Branch (HSB) at NASA's Goddard Space Flight Center (GSFC) has collected a series of surface hydrological data sets in order to enable a better understanding of the global hydrospheric cycle. These data sets include field measurements, parameters simulated from land surface models, and products derived from many satellite instruments.

NASA is mandated by Congress to make its data and products available to the broader user community. The Hydrology Data and Information Services Center (HDISC) was developed as part of the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) to archive and support data products generated by the GSFC HSB.

HDISC is a portal to a hydrology-specific, on-line, easy-access archive and distribution system, employing data analysis and visualization, data sub setting, and other user-requested techniques for better science data usage. HDISC provides convenient access to hydrology data and information from various land surface models. The first products hosted are outputs from the Global Land Data Assimilation System (GLDAS) (Rodell et al., 2004). The HDISC has the capability to support more hydrology data products and more advanced analysis tools. The

goal is to develop HDISC as a data and services portal that supports weather and climate forecast, and water and energy cycle research.

- **Objectives:** The goal of the Global Land Data Assimilation System (GLDAS) is to ingest satellite- and ground-based observational data products, using advanced land surface modeling and data assimilation techniques, in order to generate optimal fields of land surface states and fluxes (Rodell et al., 2004a).
- **Background:** GLDAS drives multiple offline (not coupled to the atmosphere) land surface models, integrates a huge quantity of observation based data, and executes globally at 2.5° to 1 km resolutions, enabled by the Land Information System (LIS) (Kumar et al., 2006). Currently, GLDAS drives four land surface models: Mosaic, Noah, the Community Land Model (CLM), and the Variable Infiltration Capacity (VIC). GLDAS products include land surface state (e.g., soil moisture and surface temperature) and flux (e.g., evaporation and sensible heat flux) parameters. For example, the total evapotranspiration for April 1979 is the average 3-hour mean rate of evapotranspiration over all the 3-hour intervals in April 1979. Table 2-4 lists some basic characteristics of the GLDAS data.

Table 2-4 Basic characteristics of the GLDAS data

Contents	Water and energy budget components, forcing data
Latitude extent	-60° to 90°N
Longitude extent	-180° to 180°E
Spatial resolution	0.25°, 1.0°
Temporal resolution	3-hourly or monthly
Temporal coverage	January 1, 1979 to present for the 1.0° data February 24, 2000 to present for the 0.25° data
Dimension	360 (longitude) x 150 (latitude) for the 1.0° data 1440 (longitude) x 600 (longitude) for the 0.25° data
Origin (1st grid center)	(179.5W, 59.5S) for the 1.0° data (179.875W, 59.875S) for the 0.25° data
Land surface models	CLM 2.0 (1.0°) MOSAIC (1.0°) NOAH 2.7.1 (1.0°) VIC water balance (1.0°) NOAH 2.7.1 (0.25°)

3.0 METHODOLOGY

3.1 A Criteria for Selecting Statistical Method

The various methods which can be used for estimating probable maximum precipitation amounts are classified into three major groups.

These are:

1. Statistical Approach,
2. Physical Approach, and
3. Empirical Approach

3.1.1 Statistical Approach

In the statistical approach the estimates of PMP are derived from frequency analysis of the annual maximum rainfall series for different durations. Statistical method for estimating PMP has been developed by Hershfield (1961, 1965) based on a general frequency equation given by Chow (1951). The use of statistical method in different countries has shown that the computed PMP estimates are closely comparable to those obtained by the meteorological method. WMO (1969, 1970, 1986, 2009) has suggested this method for estimating PMP for stations having long period of daily rainfall data. Considering this, many countries have employed the statistical method extensively for estimating PMP for stations having a long period of rainfall records (Myers 1967; Bruce and Clark, 1966; Rakhecha et al., 1992, 1994). The statistical method is useful when there is insufficient meteorological data to apply other methods.

3.1.2 Physical Approach

The physical approach is primarily concerned with the estimation of probable maximum precipitation (PMP) which can be defined as the theoretical highest precipitation amount which is physically possible over a locality for a given duration. Values of PMP are therefore dependent on the humidity content of the air and maximum efficiency of release. Values of PMP are usually estimated by

the physical method of storm transposition and maximization described by Bruce and Clark (1966, p. 230-233) or by the use of storm models such as the hurricane model used by the US Weather Bureau to make generalized estimates of PMP for Puerto Rico and the Virgin Islands (US Weather Bureau, 1961).

The storm model approach uses physical parameters, such as surface dew point, height of storm cell, and inflow and outflow, to represent the precipitation process (Collier and Hardaker 1996). Storm transposition involves translating observed storm characteristics from one or more gauged locations to the location where the PMP estimation is required (typically an ungauged location). Storm maximization consists of adjusting observed precipitation amounts upward to account for maximum atmospheric moisture convergence. Generalized PMP methods are often developed by maximizing and translating classes of storms over a broad region; storm classification in turn is based on the storm type, and storm efficiency defined as the ratio of maximum observed rainfall to the amount of perceptible water in the storm column (Collier and Hardaker 1996).

Physical methods of estimating the PMP are rather complex and require meteorological data which are often not available. They also make several assumptions which may not always be valid (Bruce and Clark, 1966, p. 231).

3.1.3 Empirical Approach

The empirical approach to the estimation of extreme rainfalls utilizes the available data just like the statistical approach. The US Weather Bureau has carried out some studies utilizing data on heavy rainfall occurrences extracted from autographic records. From these, an enveloping curve can be drawn to show the maximum rainfall likely to be obtained in any given time. The reliability of such estimates obviously depends on the duration and quality of rainfall records as well as the number of gauges involved especially if a catchment is being considered.

The ***statistical approach*** is often found to be quick and reliable and is therefore often preferred to the physical or empirical approach to the estimation of extreme rainfall. But the statistical method demands that the assumptions underlying the particular distribution function used be satisfied and the sample size used to be large.

3.2 Probable Maximum Precipitation (PMP) by Statistical Methods

Hershfield (1961, 1965) based on a general frequency equation given by Chow (1951) suggested that PMP for a station can be estimated from the following equation:

$$PMP = \overline{X}_n + Km\,\sigma_n \quad \text{.....[3.1]}$$

Where : $\overline{X}_n$ and σ_n are the mean and standard deviation for a series of n annual maximum rainfall values of a given duration respectively. **Km** is the frequency factor and is the largest of all the calculated **K** values for all stations in a given area. The value of **K** is calculated using the following equation:

$$K = (X_1 - \overline{X}_{n-1}) \Big/ \sigma_{n-1} \quad \text{.....[3.2]}$$

Where X_1, $\overline{X}_{n-1}$ and σ_{n-1} are the highest, mean and standard deviation respectively excluding the X_1 value from the series. In a survey of more than 2700 stations world over, Km values as calculated from equation 3.2 vary from less than 3 to a highest value of 14.5. Hershfield adopted the highest value rounded to 15 for estimating PMP,

$$\text{i.e. } PMP = \overline{X}_n + 15\,\sigma_n \quad \text{.....[3.3]}$$

Later Hershfield found that use of Km=15 was not appropriate. He noted that K varies inversely with mean annual maximum rainfall at any station and presented a chart for determining K_m for 5-min, 1-h, 6-h, and 24-h durations of mean annual maximum rainfall as shown below.

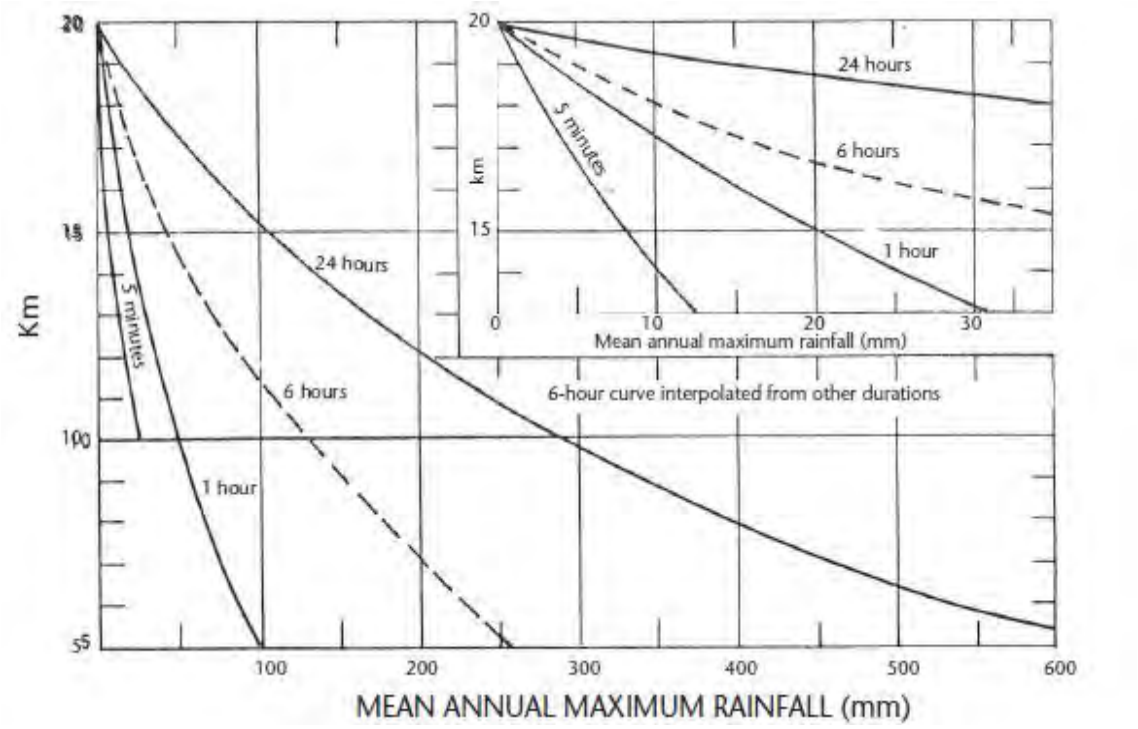


Figure 3-1 The Hershfield's chart for determination of frequency factor Km

The curves of Figure 3-1 are based on observed data from 2700 stations 90 percent of which were in the United States, where observations were at least daily for a period of at least 10 years. As a matter of fact, there are several measurements of rainfall in the United States made at locations other than where there are official gauges that exceed the PMP values calculated from this statistical procedure (Riedel, 1977). Computation of Km for Canada (McKay, 1965) indicated a maximum value of 30 associated with a mean annual maximum 24-hours rainfall amount of 15mm.

Similar research project within the Austrian Academy of Sciences (Nobilis et al., 1990) using a series of the annual daily maximum precipitation at 504 observation stations are investigated by using the method of Hershfield (WMO, 1986) for PMP-estimation The results show that according to the Hershfield method for some stations PMP amounts are evaluated which are far below the observed values. The method is found to be inadequate for series with "outliers" because

the factor of Hershfields chart for used for determination of K values is a function of the average values.

The research outputs of countries like China and Romania also showed that that their frequency factor (Km) value varies between 6 and 8.5 for their respective countries and rejected the Hershfields chart as it over estimates the PMP. (Desa et al. (2001) and M.N. Desa et al. (2003) and NIHWM, Bucharest, ROMANIA) Desa et al. (2001) and M.N. Desa et al. (2003) employed the Hershfield method to find out the appropriate frequency factor that can give reliable PMP values for stations in Malaysia for practical application.

They analyzed the series of the annual daily maximum rainfall amounts for stations in Selangor and Kelantan states and obtained the appropriate frequency factors of 8.7 and 7.4 respectively. These values are applied to calculate the PMP values in these two study areas.

In view of the above mentioned problems and resent research outputs, the Hershfield's chart might not give reliable frequency factor estimates world over. It was therefore felt that an appropriate Km value based on historical data of particular study area might give better estimates of PMP than Hershfield's chart.

3.2.1 Procedure of New Km Development

The Hershfield method is used to find out the appropriate frequency factor that can give reliable PMP values for stations in the study area for practical application. But here the annual maximum rainfall amounts series of the stations found in the study area is used for the analysis.

This involves standardizing the residual (maximum rainfall minus mean of annual maxima) by dividing it by the standard deviation to obtain the frequency factor as indicated in equation 3.2 above. The frequency factor is analogous to the normal deviate or reduced variate when normally distributed or extreme-value data are analyzed, respectively.

After determining the appropriate Km values for the study area different adjustments have to be carried out for the maximum observed events before using them for subsequent calculations

3.2.2 Adjustment of Mean and Standard deviation for Maximum Observed Events

Extreme rainfall amounts of rare magnitude or occurrence, such as with return periods of 500 or more years, are often found to have occurred at some time during a much shorter period of record, e.g, 30 years. Such a rare event, called an outlier, may have an appreciable effect on the mean and standard deviation of the annual series. The magnitude of the effect is less for long records than for short, and it varies with the rarity of the event, or outlier. This has been studied by Hershfield (1961) using the hypothetical series of varying length, and the following figures were made to show the adjustments to be made to mean and standard deviations to compensate for outliers.

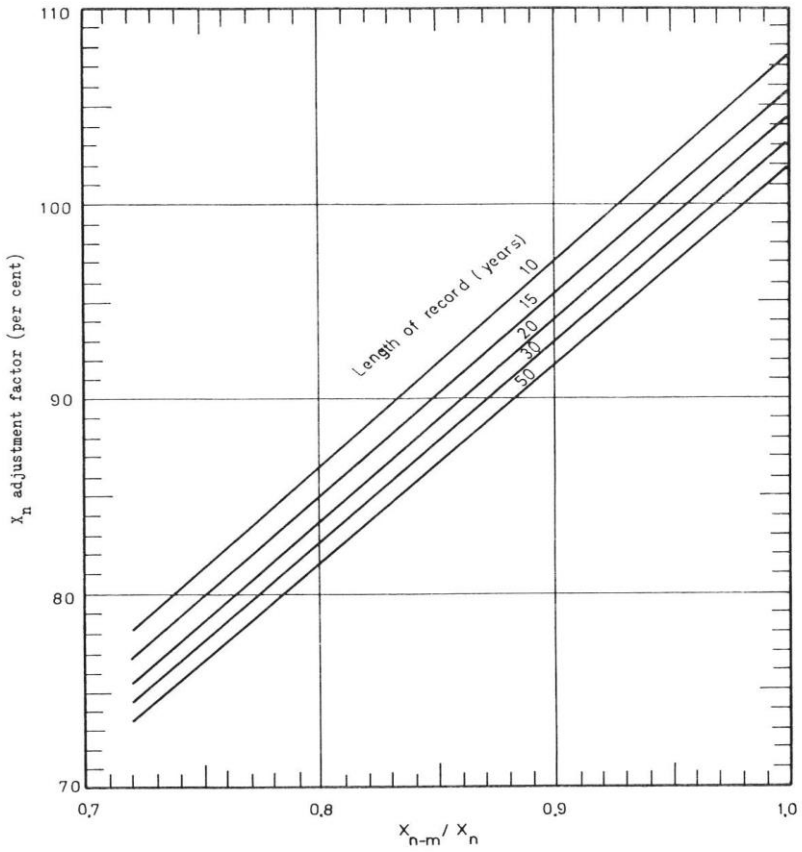


Figure 3-2 Adjustment of mean of annual series for maximum observed rainfall (Hershfield, 1961b)

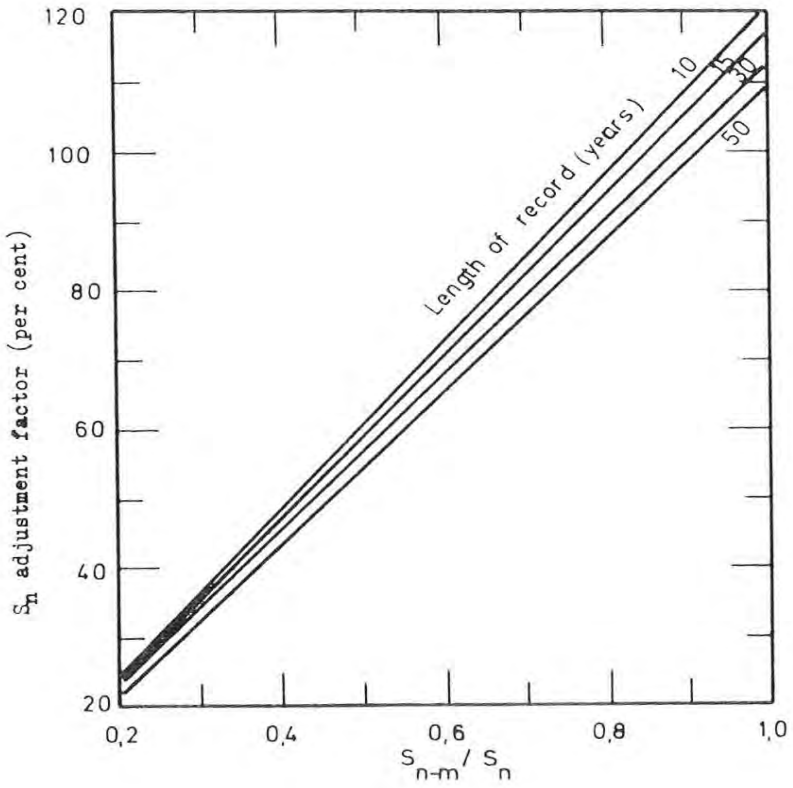


Figure 3-3 Adjustment of standard deviation of annual series for maximum observed Rainfall (Hershfield, 1961b)

In the figures X_{n-m} and S_{n-m} refer, respectively, to the mean and standard deviation of the annual series computed after excluding the maximum item in the series. It should be noted that these relationships consider only the effect of maximum observed event. No consideration was given to other anomalous appearing observations.

3.2.3 Adjustment of Mean and Standard Deviation for Sample Size

The mean and standard deviation of the annual series tend to increase with length of record, because the frequency distribution of rainfall extremes is skewed to the right so that there is a greater chance of getting a large than a small extreme as length of record increases. Figure 3-4 shows the adjustments to be made to the mean and standard deviation for length of record. There were

relatively few rainfall records longer than 50 years available for evaluating the effect of sample size, but the few longer records available indicated adjustment only slightly different from that for the 50 year records.

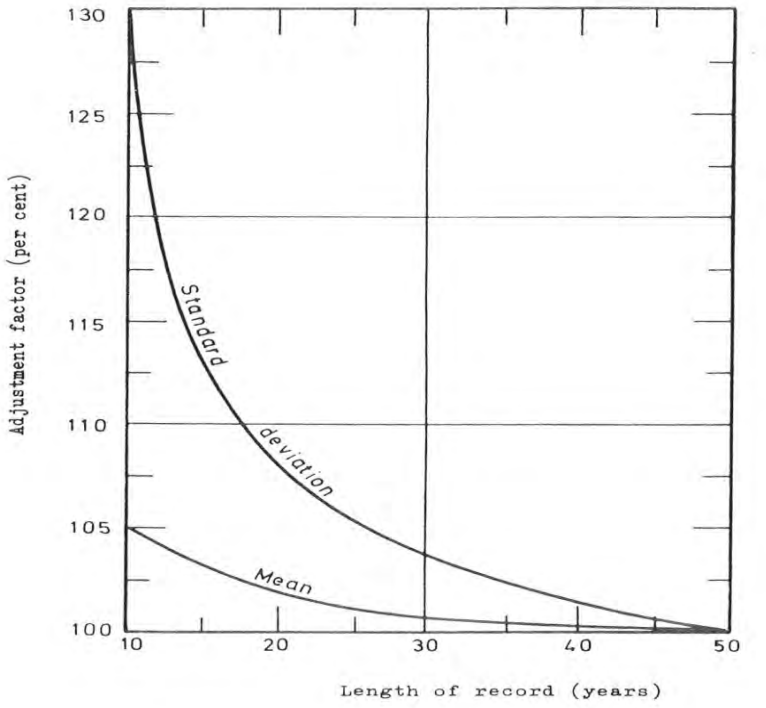


Figure 3-4 Adjustment of mean and standard deviation of annual series for length of record (Hershfield, 1961b)

3.2.4 Adjustment of Data for Fixed Observational Time Intervals

Rainfall data are usually published for fixed time intervals, e.g., 08:00-08:00 (daily), 06:00-12:00 (six-hourly), 03:00-04:00 (hourly). Such data rarely yield the true maximum amounts for the indicated durations. For example, the annual maximum observational-day amount is very likely to be appreciably less than the annual maximum amount determined from intervals of 1440 consecutive minutes unrestricted by any particular time. Similarly, maxima from fixed six-hourly and hourly intervals tend to be less than maxima obtained from 360 and 60

consecutive one-minute intervals, respectively, unrestricted by fixed beginning or ending times.

Studies of thousands of station-years of rainfall data indicate that multiplying annual maximum hourly or daily rainfall amounts for a single fixed observational interval of one to 24 hours by 1.13 will yield values closely approximating those to be obtained from an analysis of true maxima (Hershfield, 1961a). Lesser adjustments are required when maximum observed amounts are determined from two or more fixed observational intervals (Weiss, 1964; Miller, 1964). Thus, for example, maximum six and 24-hour amounts determined from six and 24 consecutive fixed one-hour increments require adjustment by factors of only 1.02 and 1.01, respectively.

3.2.5 Transformation of Point PMP to Areal PMP

Design rainfall values like PMP are generally expressed in the form of point rainfall intensity values which is the rainfall depth at a location. In order to obtain areal average values for an area, hydrologists and engineers require techniques whereby point rainfall amounts can be transformed to average rainfall amounts over a specified area. This problem of point-to-area rainfall conversion can be addressed using depth–area curves such as that of figure 3-5 which require the use of areal reduction factors. The two types of areal reduction factors commonly in use are Geographically Fixed and Storm Centered relationships (U.S. Weather Bureau, 1957, 1958a, 1958b; Miller et al., 1973; Srikanthan, 1995).

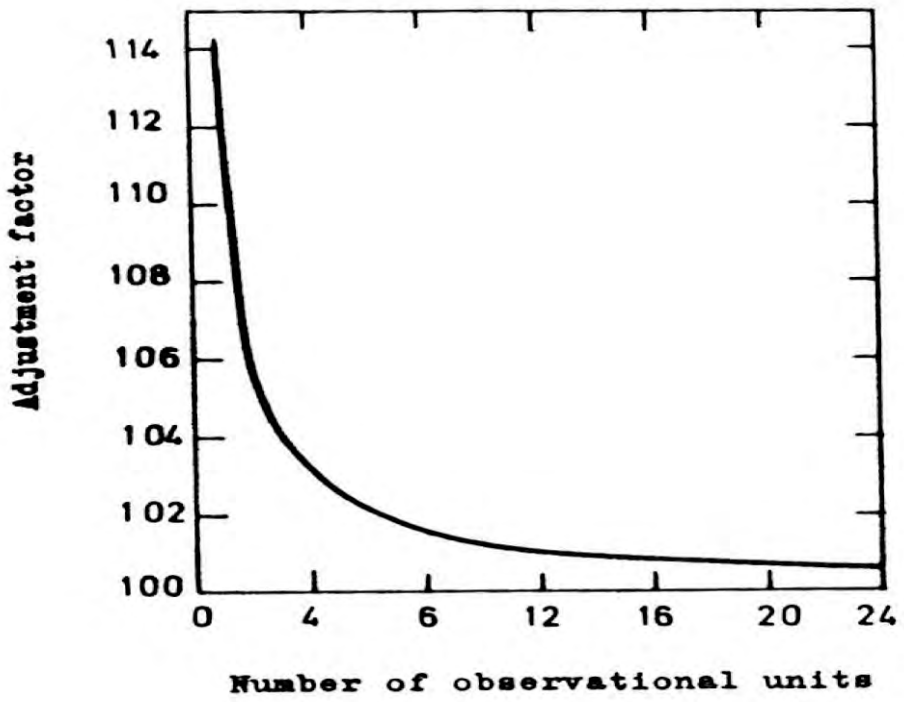


Figure 3-5 Depth area reduction curve

When the probable maximum precipitation is to be applied to an area larger than about 25 km^2, it should be reduced. No modification is considered necessary for smaller areas.

3.3 Frequency Distribution and Analysis

3.3.1 Hydrologic Frequency Analysis

The primary objective of frequency analysis is to relate the magnitude of extreme events to their frequency of occurrence through the use of probability distributions (Chow et al., 1988). Data observed over an extended period of time in a river system are analyzed in frequency analysis. The data are assumed to be independent and identically distributed. The flood data are considered to be stochastic and may even be assumed to be space and time independent. Further, it is assumed that the floods have not been affected by natural or manmade changes in the hydrological regime in the system. In practice, the true probability

distribution of the data at a site or a region is unknown. The assumption that data in a given system arise from a single-parent distribution may be questionable when data from large watersheds are analyzed. In such cases, more than one type of rainfall or flow may contribute to extreme events in a region. However, for the analysis to be of practical use, simpler distributions are often used to characterize the relation between flood magnitudes and their frequencies. The performance of distributions is evaluated by using different statistical tests. Quite often, many assumptions made in flood frequency analysis may be invalid. At any rate these assumptions have been questioned and discussed extensively (Kleme, l987a; Kleme , l987b; Yevjevich, 1968).

The distribution models which are recommended by WMO for annual maximum data series (Cunnane, 1989) are listed below.

1. Normal distribution(NOR)
2. Two parameter Log-Normal distribution(LN2) (Hazen, 1914)
3. Three parameter Log Normal distribution(LN3)
4. Exponential distribution(EX)
5. Two parameter Gamma distribution(G2) (Moran, 1957)
6. Pearson three distribution (PIII) (Foster, 1924)
7. Log Pearson three distribution (LP3) (USWRC, 1967)
8. Generalized extreme value distribution(GEV) (Jenkinson, 1955)
9. Extreme value type one distribution (EVI)
10. Weibul distribution(W) (Wu & Goodridge, 1959)
11. The five parameter Wakeby distribution(WAK5) (Houghton, 1977)
12. The four parameter Wakeby distribution(WAK4) (Houghton, 1977)
13. The generalized Pareto distribution(GP)
14. Logistic Logistic distribution(LLg) (Ahmed *et al,* 1988)
15. Generalized Logistic distribution(GLg)

The mathematical forms of these distributions are presented in Appendix D

3.3.2 Moments of Distributions

Moments about the origin or about the mean are used to characterize probability distributions. Moments about the origin are the expected values of powers of a random variable. In frequency analysis the two popular moments these are conventional moments and L-moments.

3.3.2.1 Conventional Moments

For a given distribution, conventional moments can be expressed as functions of the parameters of distributions. It follows that the higher order moments can be expressed as functions of lower order moments. The method of moments has been one of the simplest and conventional parameter estimation techniques used in statistical hydrology. In this method, while fitting a probability distribution to a sample, the parameters are estimated by equating the sample moments to those of the theoretical moments of the distribution. Even though this method is conceptually simple, and the computations are straight-forward, it is found that the numerical values of the sample moments can be very different from those of the population from which the sample has been drawn, especially when the sample size is small and/or the skewness of the sample is considerable.

3.3.2.2 L-Moments

Recently, Hosking (1990) has defined L-moments, which are analogous to conventional moments, and can be expressed in terms of linear combinations of order statistics. Basically, L-moments are linear functions of probability weighted moments (PWMs).

The following are advantage of L-moments Cunnane, (1989):

- Compared to method of moments, L-moments can characterize a wide range of distributions
- Sample estimates of L-moments are so robust that they are not affected by the presence of outlier in the dataset and are less subjected to bias in

estimation L-moments yield more accurate estimates of the parameters of a fitted distribution.

The following L-Moments are defined in (Cunnane, 1989):

$\lambda_1 = L_1 = M100$

$\lambda_2 = L_2 = 2M110 - M100$

$\lambda_3 = L_3 = 6M120 - 6M110 + M100$

$\lambda_4 = L_4 = 20M130 - 30M120 + 12M110 - M100$

The 4 L-Moments (λ_1, λ_2, λ_3, λ_4) are all derived using the 4 PWMs. Other useful ratios are L-CV (τ_2), L-Skewness (τ_3) and L-Kurtosis (τ_4).

L-C_V is similar to the normal coefficient of variation (C_V). The standard equation for C_V = standard deviation/mean, and shows how the data set varies. The larger the C_V value, the larger the variation of the data set from the mean. For example, in arid regions that receive few storm events, the variation will be large, as one storm will deviate greatly from the low mean.

$\tau_2 = L_2/L_1$ (L-C_V)

L-Skewness is a measure of the lack of symmetry in a distribution. If the value is negative, the left tail is long compared with the right tail, and if the value is positive, the right tail is longer.

For GEV frequency analysis, a positive L-Skewness value is desired, as we are interested in the extreme events that occur in the right side tail of the distribution.

$\tau_3 = L_3/L_2$ (L-Skewness)

L-Kurtosis is difficult to interpret, however is often described as the measure of "Peaked ness" of the distribution (Hosking, 1997). L-kurtosis is much less biased than ordinary kurtosis.

$\tau_4 = L_4/L_2$ (L-Kurtosis)

Where, L1 = measure of location

τ_2 = measure of scale and dispersion (LCv)

τ_3 = measure of skewness (LCs)

τ_4 = measure of kurtosis (LCk)

3.3.3 Method of Parameter Estimation

Numerous parameter estimation procedures have been proposed and studied in order to investigate their performance for various distributions (GUO, 1990). In the past only the ordinary methods of moments (MOM) was mentioned for parameter estimation. It should be noted that MOM, PWM and MLM are the most efficient method of parameter estimation available which are discussed as follow:

3.3.3.1 Method of Moments (MOM)

It is one of the most commonly used methods of estimating parameters of a probability distribution. The estimates of the parameters of a probability distribution function are obtained by equating the moments of the sample with the moments of the probability distribution function. It provides simple calculations, but higher order moment estimates are biased (Wallis, et. al. 1974). Parameter estimation by MOM is known to be biased and inefficient especially with three parameter distributions. Method of moments (MOM) is a relatively easy parameter estimation method. Unfortunately, MOM estimates are usually inferior in quality and generally not as efficient as the ML estimates especially in the case where the distributions have a large number of parameters. This is due to the fact that higher order moments are more likely to be highly biased in relatively small samples.

3.3.3.2 Method of Maximum Likelihood (MML)

The maximum likelihood method (MLM) is often regarded as the most efficient method. This is because it provides the smallest sampling variance of the estimated parameters which leads to the smallest sampling variance of the estimated quantiles compared to other methods. MLM has disadvantages in some particular cases, such as the Pearson type III distribution where the optimality of the MLM is only asymptotic and small sample estimates may lead to estimates of inferior quality (Bobée et al., 1993). Another disadvantage is that MLM often gives biased estimates. However, these biased estimates can be

corrected. Furthermore, MLM might be hard to compute especially if the number of parameters is large. This will in turn make it hard and might also be impossible to obtain ML estimates of small samples.

Estimation by the Maximum Likelihood (ML) method involves the choice of parameter estimates that produce a maximum probability of occurrence of the observations. The parameter estimates that maximize the likelihood function are computed by partial differentiation with respect to each parameters and setting these partial derivatives equal to zero and finally solve the resulting set of equations simultaneously. The equations are usually complex that can only be solved by numerical techniques. As a result of this difficulty, the solution set may not properly found. (Rao & Hamed, 2000).

3.3.3.3 Method of Probability Weighted Moments (PWM)

The probability weighted moments (PWM) method (Greenwood et al., 1979; Hosking, 1986) gives parameter estimates comparable to the ML estimates. In fact, in some cases the estimation procedures are much less complex and thus less complicated since the computations are simpler than that of ML estimates. Landwehr et al., (1978) stated that the parameter estimates from small samples using PWM are sometimes more accurate than the ML estimates.

Parameter estimates are obtained in this method, as in the case of MOM, by equating moments of the distributions with the corresponding sample moments of observed data. For a distribution with k parameters, the first k sample moments are set equal to the corresponding population moments.

The resulting equations are then solved simultaneously for the unknown parameters. Parameter estimation by PWM, which is relatively new, is as easy to apply as ordinary moments (MOM), is usually unbiased and is almost as efficient as ML. Indeed, in small samples PWM may be as efficient as ML. With a suitable choice of distribution PWM estimation also contributes to robustness and is attractive from that point of view. Another attraction of the PWM method is that it can be easily used in regional estimation schemes. (Roa & Hamed, 2000).

3.3.4 Selection of Parameters and Quantile Estimation

Parameters of the best fitted distributions are estimated based on the most commonly used methods. These are:

- Method of moments (MoM)
- Method of maximum likelihood (ML)
- Method of probability weighted moments (PWM)

After which, quantile estimates (X_T) corresponding to different return periods may be computed. The relation between return period and the probability of non-expedience (F) is given by

$$F = 1 - \frac{1}{T} \quad \text{..... [3.4]}$$

Where; F=F(X_T) is the probability of having a flood of magnitude X_T or smaller. The problem thus reduces to evaluating X_T for a given value of F.Chow (1964) proposed a general for calculating X_T as follows.

$$X_T = u_1' + K_T\sqrt{\mu_2} \quad \text{..... [3.5]}$$

Where; K_T is the frequency factor which is a function of the return period and of the parameters of the distribution $u_1' \quad and \ \mu_2$ are the moments of the distribution It is clear that a point estimate of a certain quantile corresponding to a return period may be of no real significance unless there is an indication of the accuracy of the estimate. A measure of the variability of the estimated value is the standard error of estimate S_T which is defined as (Cunnane, 1989)

$$S_T = \sqrt{E\left\{\hat{X}_T - E\left(\hat{X}_T\right)\right\}^2} \quad \text{..... [3.6]}$$

The standard error of estimate accounts for the error due to small samples, but not the error due to the choice of inappropriate distribution. The standard error of estimate depends in general on the method of parameter estimation. The most efficient method is that which gives the smallest standard error of estimate (Rao, 2000).

4.0 DATA AVAILABLITY AND ANALYSIS

4.1 Rainfall Data Source

The in situ daily rainfall data was collected from national meteorological agency (NMA) and from Reports of previous projects, which took their data mainly from NMA. And the annual maximum of reanalysis data for 1 day, 2 day and 3 days duration are taken from European Centre for Medium-Range Weather Forecasts (ECMWF) and Global Land Data Assimilation System (GLDAS) from the following link http://www.ecmwf.int/ and http://disc.sci.gsfc.nasa.gov/service/grads-gds/glads respectively. Additionally, the study used ECMWF with bias corrected reanalysis data.

4.2 Data Availability

There are more than 173 stations in the UBNB which satisfies international standards. Even though the number of stations reaches to the above mentioned number, the distributions along the sub basins like Meteorological data are cluster to some of the basin. Here in this paper 104 rainfall stations for 1-day duration and for 2 & 3 days 93 stations are collected and analyzed. The basic information for available stations are listed on *Appendix A*. and the annual maximum for 1 day, 2 & 3 days of the in-situ data prepared from the daily rainfall data and shown in Appendix B (Table B1) Figure 4 -1 shows Distribution of rainfall stations over Upper Blue Nail Basins.

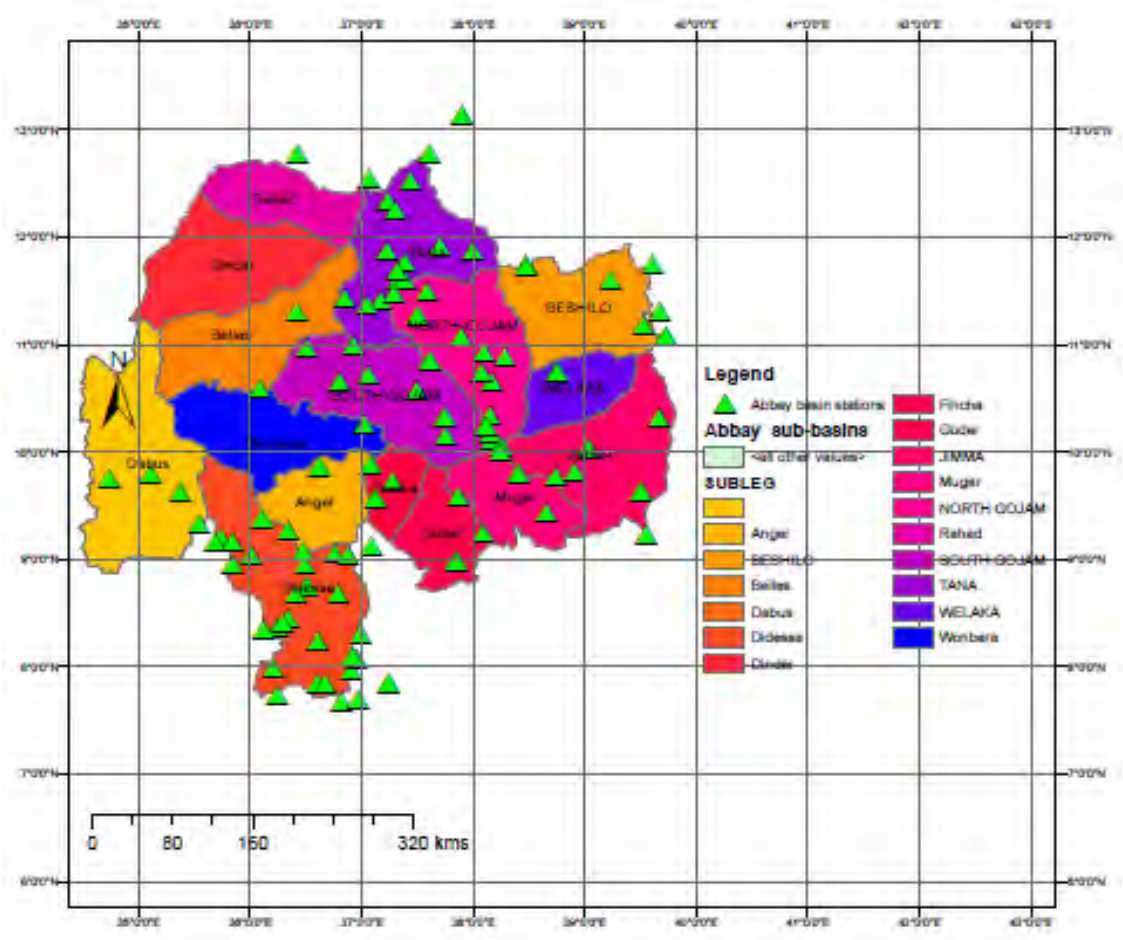


Figure 4 -1 Distribution of Rainfall stations over Upper Blue Nile Basins

The reanalysis data of ECMWF and GLADS prepared in center of grid box that contains the available stations by the grid size of 0.5 by 0.5 degree of longitude and latitude for ECMWF and 0.25 by 0.25 degree of longitude and latitude for GLADS. The station distribution on the reanalysis grid box map for GLADS shown on Figure 4 -2.

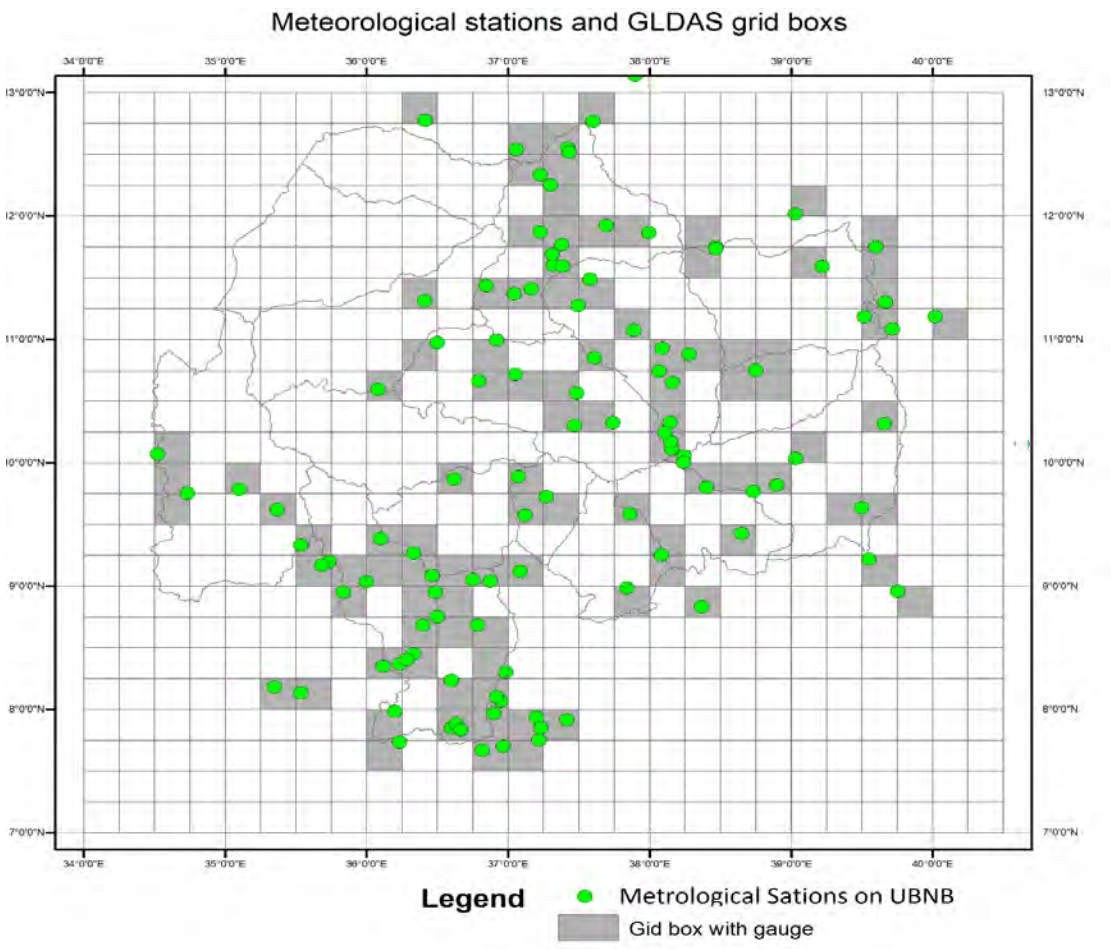


Figure 4 -2 station distribution on 0.25-degree grid box of GLADS

The annual maximum of reanalysis data for 1 day, 2 & 3 days' duration for the available stations collected from nearest grid box by approximate the available stations longitude and latitude with the grid box longitude and latitude. For all the approximated longitude and latitude stations and the annual maximum reanalysis data for both ECMWF and GLADS are shown in *Appendix B (Table B2 and B3).*

4.2.1 Gauge Stations for the Respective Sub Basin of UBNB

Table 4.1 shows the summary of Hydro-meteorological networks in the Upper Blue Nile Basin. From table 4.1 one can understand that for sub basins Dinder do not have any rainfall gauges. Sub Basins Rahad, Wonbera and Welaka have only one station which have not a capacity to represent the sub basin. The data gathered

from the available Rain gauged stations have also problem in recording, missing data and operational case.

Table 4.1 Summary of meteorological networks in Upper Blue Nile Basin

No.	Sub-Basin	Number of Rain Gauges Stations
1	Anger	5
2	Belles	2
3	Beshilo	7
4	Dabus	5
5	Dinder	0
6	Didessa	28
7	Fincha	2
8	Guder	3
9	Jemma	8
10	Muger	3
11	North Gojjam	11
12	Rahad	1
13	South Gojjam	8
14	Tana	19
15	Welaka	1
16	Wonbera	1
	Total	**104**

4.3 Data Quality Control

In order to get good results, the qualities of the data should be investigated though different methods of checking. Under flood frequency analysis the following tests, are commonly used, such are test for Outliers, homogeneity, and independence of data which are discussed by Bobee and Ashkar (1991).

4.3.1 Checking of Reanalysis Precipitation Product with the In-Situ Data

4.3.1.1 Using t mean test

One side t mean hypothesis test is used to compered the reanalysis products (ECMWF, ECMWF bias corrected and GLADS) with the in-situ data. the computed t value at standard significance (α) 0.05 for 1-day duration shows the

reanalysis products for ECMWF fitted 61 number of stations, ECMWF bias corrected fitted 7 number of stations and GLADS fitted 15 number of stations.

4.3.1.2 Using the scatter graph and R^2 Value

The scatter graph developed by considering all the stations data's as a single data for both in situ and reanalysis product. the scatter graph for 1-day duration are:

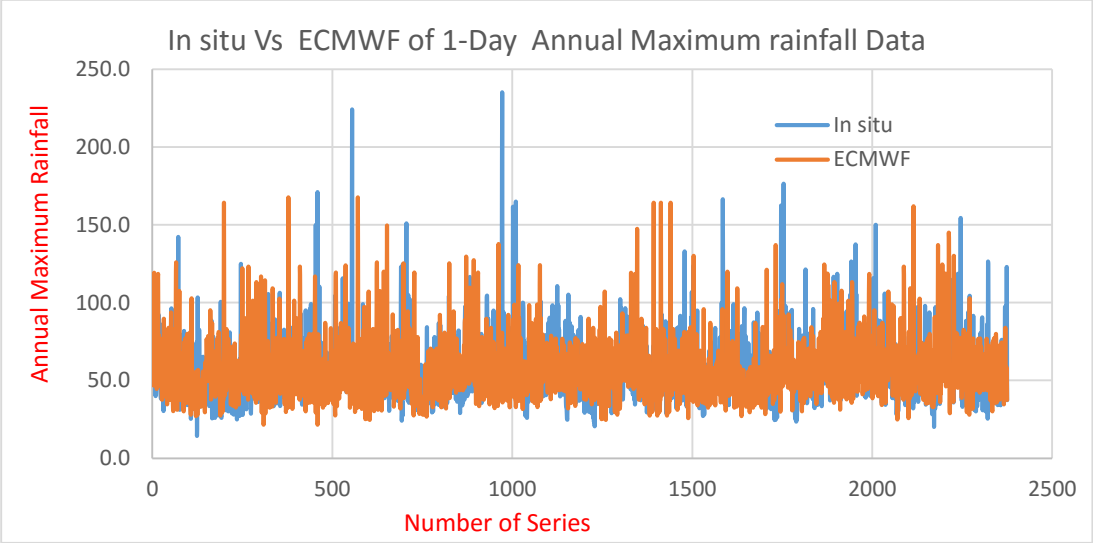


Figure 4-3 the scatter graph In-situ with ECMWF Product.

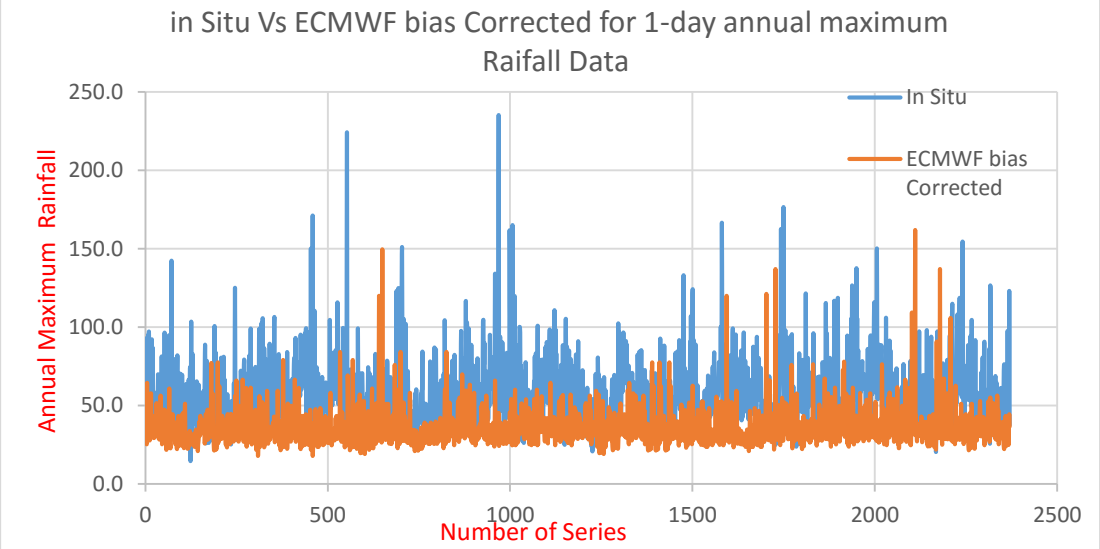


Figure 4-4 the scatter graph In-situ with ECMWF bias Corrected Product.

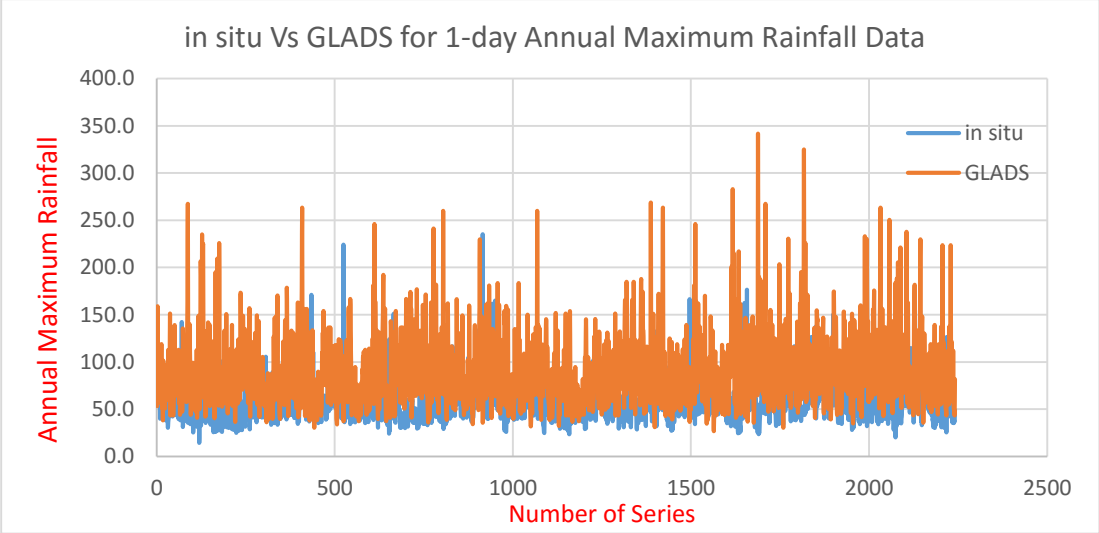


Figure 4-5 the scatter graph In-situ with GLADS Product.

As a basin figure 4-3,4-4 & 4-5 shows for a 1-day duration ECMWF product averagely represent the in-situ data rather than ECMWF bias corrected & GLADS products, and with respect to in-situ data the ECMWF bias corrected product is too much low and GLADS product is high. Using the linear scatter relation of in-situ with reanalysis product the R^2 value for ECMWF, ECMWF bias corrected and GLADS products are 0.0124, 0.0011 & 0.0002 respectively. This value shows the daily annual maximum of reanalysis products are not representing the in-situ daily annual maximum data.

4.3.2 Testing for Outliers

An outlier is an observation that deviates significantly from the bulk of the data, which may be due to errors in data collection, or recording, or due to natural causes. The presence of outliers in the data causes difficulties when fitting a distribution to the data. Low and high outliers are both possible and have different effects on the analysis.

The Grubbs and Beck (1972) test (G-B) may be used to detect outliers. In this test the quantities X_H and X_L are analyzed using the following equations.

$$X_H = \exp(\overline{X} + K_{NS}) \quad [4.1]$$
$$X_L = \exp(\overline{X} - K_{NS})$$

Where : $\overline{X}$ and S are the mean and standard deviations of the logarithm of the annual rainfall peaks, respectively, and K_n , is detected and K_n , is the G-B statistic tabulated for various sample sizes and significant levels by Grubbs and Beck(1972). At 10% significant level, the following approximation proposed by Pilon et al.(1985) is used.

$$K_N = -3.62201 + 6.28446N^{1/4} - 2.49835N^{1/2} + 0.49146N^{3/4} - 0.037911N \quad [4.2]$$

Where N is the sample size

The result of the outliers' test for ECMWF with bias Corrected 3-day duration of rainfall depths for Wegel Tena Station indicated in Table 4-2

Table 4-2 Outliers Test for Wegel Tena Station

Outlier test of Wegel Tena Station for 3-days of ECMWF with bias Corrected data					
Mean	STDEV	Limiting Value		Data Range	
		Upper (XH)	Lower (XL)	Max	Min
2.568	0.313	150.178	30.172	247.100	45.787

The extreme rainfall events not necessarily bounded by these limits but these test will help to sort out the exaturated values from the series that might be due to reading error or other errors.

4.3.3 Test for Independence

It is usually assumed that all the peak magnitudes in the AM series are mutually Independent in the statistical sense. This assumption is usually justified. A

hydrologic time series is stationery if it is free of trends, shifts or periodicity (cyclicity) which implies that the statistical parameters of the series, such as the mean, variance, and autocorrelation structure do not change over time (Maidment, 1993).

The statistical analysis for dependence is carried out for all the 1-day durations of in-situ rainfall record with in each station. A FORTRAN program is used for the analysis based on Wald –Wolfowitz (W –W) test. Out of the analyzed data for annual maximum rainfall series of one-day duration of in-situ data, 9 stations were found to be dependent using W-W test. The summarized results and criteria for dependency are shown in *Appendix C.*

4.3.4 Homogeneity Test for the Data Series

The use of a longer series in the estimation of PMP is appropriate only if they show no significant increasing or decreasing trends.

The presence or absence of trends in the annual maximum rainfall series for the 104 rainfall stations used were investigated using the Mann-Kendall rank statistics test (WMO, 1966).

In this test two samples of size *p* and *q* with p ≤ q are compared. The combined data set of size *N* = *p* + *q* is ranked in increasing order. The Mann-Whitney (1947) (M-W) test considers the quantities *V* and *W* in Equation. 4.3 and 4.4.

$$V = R - \frac{(p(p+1))}{2} \quad \text{[4.3]}$$

$$W = pq - V \quad \text{[4.4]}$$

R is the sum of the ranks of the elements of the first sample (size *p*) in the combined series (size *N*), and *V* and *W* are calculated from *R*, *p*, and *q*. *V* represents the number of times an item in sample 1 follows an item in sample 2 in the ranking. Similarly, *W* can be computed for sample 2 following sample 1. The M-W Statistic *U* is defined by the smaller of *V* and *W*. When *N* > 20 and *p*, *q* > 3, and under the null hypothesis that the two samples came from the same

population, *U* is approximately normally distributed with mean $U_{mean} = \frac{p+q}{2}$ and variance var (*U*),

$$Var\ (U) = \left[\frac{pq}{N(N-1)}\right]\left[\frac{N^3 - N}{12} - \sum T\right] \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [4.5]$$

where $T = J^3 - J/12$ and J is the number of observations tied at a given rank. *T* is summed over all groups of tied observations in both samples of size *p* and *q*. The statistic $u=(U - U_{mean})/[Var(U)]^{1/2}$ is used to test the hypothesis of homogeneity at significance level α by comparing it with the standard normal variate for that significance level.

For no trend in the data series, this value should lie within the limits of ± 1.96 at the 5% level of significance. The test by Mann-Kendall showed that no significant trend in the annual maximum rainfall values exists at all of stations. Hence, the annual maximum rainfall series for all the stations are treated as homogeneous for subsequent calculation.

Table 4-3: Homogeneity test result of Wegel Tena station for 1-day in-situ data

Mann-kendall's rank statistics test result (WMO 1966)		Remarks
Station name	Wegel Tena	
Sample Size	31	
Sample1 (p)	15	
Sample 2 (q)	16	
Number of Observation tied (J)	4	
Sum of the tied	5	
Var (U)	638.710	using equation(3.5)
Standard test result for 5% significant level (u)	0.594	<1.96

As shown in the table 4-3 the standard test for Wegel Tena station for 5% significant level was found to be less than 1.96 therefore no significant trend in the annual maximum rainfall values exist. Hence, the annual maximum rainfall series for the station is treated as homogeneous for subsequent calculation.
For all the rest of stations shown in *Appendix C.*

5.0 RESULTS AND DISCUSSION

5.1 The Rainfall Frequency Analysis

Previously a criterion used for the dam crest level and the emergency spillway dimension designs were the 10,000 years return period floods. In order to compare some of the present study results a 1day, 2 and 3 days PMPs with the 10,000 years return period rainfall events this procedure is required.

Rainfall frequency analysis is a methodology which comprises data preparation, selection of frequency distribution, method of parameter estimation and computing rainfall quantiles for different durations.

5.1.1 Selection and Evaluation of Parent Distributions for the Rainfall Data

Frequency distributions can be described by their moments. The two most commonly used moment ratio diagrams: The Conventional Moment Ratio Diagram (MRD) and the L-moment Ratio diagram (LMRD) which are used to select the parent distribution of a particular station which helps for the estimation of the rainfall events of different recurrence intervals using different parameter estimation methods.

Figure 5-1 and Figure 5-2 indicates the graph of MRD and L-MRD and the candidate distributions for in-situ 1-day duration annual maximum rainfall at Finoteselam station. The same analysis could be applied to fit the best distribution to each station data.

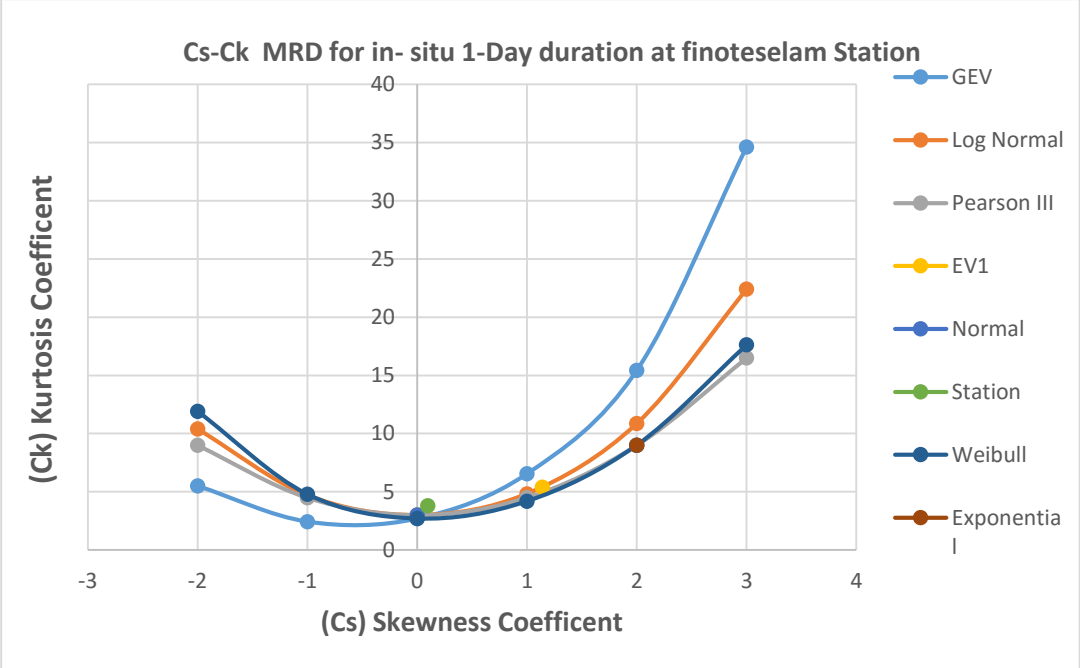


Figure 5-1: MRD for 1-day in-situ rainfall depth at Finoteselam station

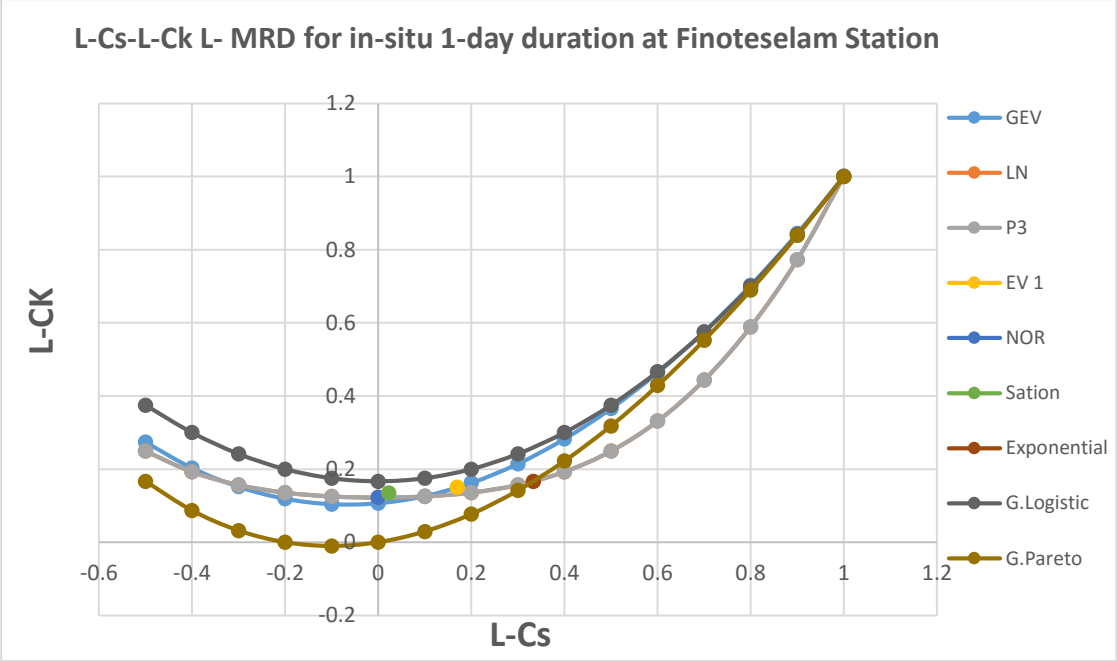


Figure 5-2: L-MRD for 1-day in-situ rainfall depth at Finoteselam station

As Figure 5-1 and 5-2 shown the candidate distribution for in-situ 1-day duration at Finoteselam station. The summarized distributions are shown in Table 4-1 below.

Table 5 -1: Candidate distributions for Finoteselam station

Candidate distributions for 1-day in-situ data of Finoteselam Stations								
Conventional Moments				Candidate distributions	Average L-Moments			Candidate distributions
X_{mean}	Cv	Cs	Ck		t	t_3	t_4	
50.336	0.191	0.095	3.809	**NOR/GEV/LN(3)**	0.124	0.022	0.259	**NOR/ PIII/ GL**

As table 5-1 shown the normal distribution selected as best candidate distributions for finoteselam station.

5.1.2 Parameters Selection and Quantile Estimation

Using standard error of estimate (SEE) were selected the fitted Parameter estimation method and then computed the quantile estimates (X_T) corresponding to different return periods. The standard error of estimate (SEE) for annual maximum rainfall of In-situ 1-day duration in the different return periods for Finoteselam station are shown in tables 5-2.

Table 5-2 Standard Error of different parameter estimation Methods for the best fitted distributions

Method of Parameter estimation	Standard Errors of Estimates for the indicated return periods in years								
	2	10	20	50	100	200	500	1000	10000
NOR/MOM	1.3881089	1.87338879	2.129452	2.447896	2.672593	2.884628	3.147948	3.335988	3.905484
NOR/MLM	1.3881089	1.87338879	2.129452	2.447896	2.672593	2.884628	3.147948	3.335988	3.905484
NOR/PWM	1.596481	2.16555945	2.464972	2.836856	3.099042	3.34633	3.653301	3.872444	4.535873

Quantiles of different return periods were estimated using the parameters with smallest standard error of estimate for the best fitted distributions. The best fitted candidate distributions of in-situ 1-day rainfall durations and the method of parameters and quantiles estimator for all stations in the basin are shown in table 5-3.

Table 5-3 Best Fitted distributions and method of parameter estimation

Best Fitted distributions and method of parameter estimation for the in situ 1-Day durations					
Station Name	Fitted distributions	Station Name	Fitted distributions	Station Name	Fitted distributions
Abasina Joger	P III/PWM	Debre Markos	P III/MOM	Lemi	P III/PWM
Abay Sheleko	EV I/PWM	Debre Tabor	GEV/PWM	Limu Genet	P III/PWM
Abdela	P III/MOM	Debre Work	GEV/PWM	Maligawa	GEV/PWM
Adet	P III/PWM	Dedessa	P III/PWM	Mehal Meda (RS)	P III/MOM
Agaro	NOR/PWM	Dedessa river	P III/MOM	Mekne selam	GEV/MOM
Alem Ketema	GEV/PWM	Dejen	GEV/PWM	Mendi	P III/MOM
Alibo	LN/MOM	Deke Istifanos	P III/MOM	Merawi	P III/PWM
Amba mariam	GEV/MOM	Dembecha	P III/PWM	Merto Lemariam	P III/PWM
Ambagiorgis Sch	P III/MOM	Dengoro	P III/MOM	Meshenti	EV I/PWM
Ambo Agriculture	LN/MOM	Derba	P III/MOM	Metema	GEV/PWM
Ambo Met	P III/PWM	Dimtu	GEV/PWM	Motta	EV I/PWM
Angerguten	P III/MOM	Enango	EV I/PWM	Mukelemi	LN/MOM
Arbgebeya	EV I/PWM	Enjabara	P III/PWM	Muletadiga	P III/MOM
Arjo	GEV/PWM	Felege Berhan	P III/PWM	Nefas mewucha	GEV/MOM
Assosa	GEV/PWM	Feres Bet	GEV/PWM	Nekemte	P III/MOM
Atnago	P III/PWM	Fiche	GEV/PWM	Neshi	NOR/PWM
Ayehu	GEV/PWM	Filiklik	GEV/PWM	Nolekaba	EV I/PWM
Aykel	EV I/PWM	Finoteselam	NOR/MOM	Pawe	P III/MOM
Baco	EV I/PWM	Gatira	LN/MOM	Serbo	GEV/PWM
Bahir Dar (Airport)	P III/PWM	Gebre guracha	P III/MOM	Shambu	LN/PWM
Bahir Dar New	NOR/PWM	Gembe	P III/MOM	Shola Gebeya	P III/MOM
Bambase	P III/MOM	Gidayana	NOR/PWM	Sibusire	LN/MOM
Baro (Yaya-Hurum)	P III/PWM	Gimijabet Mariam	GEV/PWM	Sirinka	GEV/PWM
Bedele	GEV/PWM	Gohatsion	GEV/PWM	Tillili	EV I/PWM
Bullen	GEV/PWM	Gondar	P III/PWM	Tis_Abay	EV I/PWM
Chagni	P III/MOM	Gondar A.P.	P III/MOM	Wegel Tena	GEV/PWM
Chewahit	P III/MOM	Gorgora	EV I/PWM	Werejiru	GEV/MOM
Chira	EV I/PWM	Gundo Woin	LN/MOM	Wereta (Add)	GEV/PWM
Chora	P III/PWM	haike	GEV/PWM	Wetet Abay	P III/MOM
Combolcha	NOR/MOM	Hamusit	GEV/PWM	Yanfa	P III/MOM
Dangila	GEV/PWM	Jeldu	P III/MOM	Yejubie	P III/MOM
Debark	P III/MOM	Jimma	P III/PWM	Yetemen	P III/PWM
Debena	P III/PWM	Kachis e(Rs)	P III/MOM	Yetnora	P III/PWM
Debre Berhan	GEV/PWM	Kelem Meda	EV I/PWM	Zege	P III/PWM
Debre Elias	GEV/MOM	Kone	GEV/PWM		

As the Table 5-3 shown for the in-situ 1-day duration the candidate distribution of the majority stations in the study area were General Extreme Value (GEV) and Pearson(III).

Among various frequency distributions, the generalized extreme value (GEV) theory has been recently applied in hydrological studies by many researchers, to determine extreme rainfall values associated with large return periods (Koutsoyiannis,1999, 2004; Lee and Maeng,2003; Haktanir,2004; Michele and Salvadori, 2005). Based on this recommendation and the fitted distribution as shown on Table 5-3 the generalized extreme value (GEV) distribution is used for both 2 & 3 days' in-situ and 1 day, 2 & 3 days' reanalysis precipitation product to estimating quantiles of different durations.

Table 5-4 Estimated Quantiles of different durations for finoteselam station

Return Period (years)	Estimated Quantiles for the indicated durations of in-situ rainfall, mm at Finoteselam station		
	1-day	2-days	3-days
2	50.336	73.634	87.980
10	62.662	85.278	108.626
20	66.158	88.617	116.474
50	70.091	92.235	126.598
100	72.713	94.507	134.160
200	75.112	96.454	141.674
500	78.019	98.613	151.555
1000	80.058	99.984	158.998
10000	86.103	103.306	**183.564**

Estimated Quantiles of different durations for in-situ, ECMWF, bias Corrected ECMWF, GLADS of 1 day, 2 & 3 days' duration are shown in *Appendix E.*

5.2 Probable Maximum Precipitation (PMP)

In view of the mentioned problems in the methodology part and recent research outputs, the Hershfield's chart might not give reliable frequency factor estimates world over. It was therefore felt that an appropriate Km value based on in-situ and reanalysis product of particular study area would give better estimates of PMP than Hershfield's chart.

5.2.1 Determination of Frequency Factor (K) Values Using Hershfield's Frequency Equation for UBNB

Following the same procedure explained in section three and using the statistical values of the stations in the basin the frequency factor K for each rainfall station was computed by using equation 3.2.

Table 5-5 shows the k value for in-situ 1-day duration at finoteselam station.

Year	Rainfall depths(Xn) of 1-day duration in mm	Rainfall depths (Xn-1) in mm Excluding the 70 mm Rainfall depth
1993	54	54
1994	43.8	43.8
1995	53	53
1996	40	40
1997	34.7	34.7
2006	49.7	49.7
2007	36	36
2008	59.7	59.7
2009	**70**	
2010	58.5	58.5
2011	53.4	53.4
2012	50.6	50.6
2014	54.6	54.6
2015	46.7	46.7
Max (X1)		70
mean of Xn-1 (mm)		48.823
St Dev of Xn-1 (mm)		8.093
Frequency factor (K)		**2.617**

The distribution of K values for the 104 rainfall stations of in-situ 1-day duration are given below.

Table 5-6 The frequency factor K values for in-situ 1-day duration of the meteorological stations in the Upper Blue Nile Basin

Station Name	K	Station Name	K	Station Name	K
Abasina Joger	1.757	Debre Markos	**10.555**	Lemi	2.715
Abay Sheleko	2.429	Debre Tabor	4.533	Limu Genet	2.586
Abdela	4.987	Debre Work	3.502	Maligawa	2.705
Adet	2.357	Dedessa	2.747	Mehal Meda (RS)	2.708
Agaro	8.314	Dedessa river	2.489	Mekne selam	2.799
Alem Ketema	3.348	Dejen	3.211	Mendi	4.005
Alibo	3.424	Deke Istifanos	6.174	Merawi	2.028
Amba mariam	2.011	Dembecha	3.128	Merto Lemariam	2.403
Ambagiorgis Sch	4.301	Dengoro	3.362	Meshenti	2.487
Ambo Agriculture	4.336	Derba	2.977	Metema	4.609
Ambo Met	2.632	Dimtu	2.716	Motta	2.531
Angerguten	7.755	Enango	3.431	Mukelemi	4.115
Arbgebeya	2.253	Enjabara	2.634	Muletadiga	3.952
Arjo	4.042	Felege Berhan	3.429	Nefas mewucha	4.811
Assosa	2.464	Feres Bet	2.092	Nekemte	3.036
Atnago	3.093	Fiche	3.037	Neshi	2.170
Ayehu	3.480	Filiklik	3.364	Nolekaba	2.438
Aykel	4.010	Finoteselam	2.617	Pawe	3.938
Baco	3.210	Gatira	3.307	Serbo	3.357
Bahir Dar (Airport)	1.646	Gebre guracha	1.160	Shambu	3.357
Bahir Dar New	1.786	Gembe	6.230	Shola Gebeya	1.763
Bambase	4.682	Gidayana	1.913	Sibusire	2.661
Baro (Yaya-Hurum)	2.168	Gimijabet Mariam	4.750	Sirinka	2.708
Bedele	4.796	Gohatsion	2.744	Tillili	4.087
Bullen	4.352	Gondar	2.696	Tis_Abay	2.344
Chagni	9.851	Gondar A.P.	3.115	Wegel Tena	5.956
Chewahit	3.590	Gorgora	2.826	Werejiru	3.350
Chira	2.153	Gundo Woin	4.908	Wereta (Add)	2.213
Chora	2.168	haike	3.616	Wetet Abay	6.435
Combolcha	2.546	Hamusit	3.921	Yanfa	2.700
Dangila	2.827	Jeldu	2.727	Yejubie	5.457
Debark	2.834	Jimma	2.376	Yetemen	3.946
Debena	4.865	Kachis e(Rs)	7.248	Yetnora	2.395
Debre Berhan	4.184	Kelem Meda	2.293	Zege	4.172
Debre Elias	3.532	Kone	2.763		

As shown in Table 5-6. most of the K values for 1-day duration were less than 5.0. Only Ten values were in the range between 5 and 11 with the latter being the highest one. Thus, the highest value of (Km) for the in-situ 1-day duration was found to be 10.555 or approximately 11 in the study area which is the required frequency factor of the study area for the in-situ 1-day annual maxima series.
For durations of 2 and 3 days of the in situ data the frequency factors Km values are found to be 8.326 and 9.002 respectively. The K values of ECMWF, bias Corrected ECMWF, GLADS of 1 day, 2 & 3 days' duration and in-situ data 2 & 3 days' durations are shown in Appendix F. The table 5-7 shows the number of stations which occurred in the given k value range for 1-day duration of both in-situ and reanalysis products

Table 5-7 Number of stations for the given k value range for a 1-day duration of UBNB

	Number of Stations for the computed K value				
Data Source	**k <3**	**3-5**	**5-9**	**k >9**	**k < 5**
In situ	49	45	8	2	**94**
ECMWF	40	41	23	0	**81**
ECMWF bias corrected	25	53	24	2	**78**
GLADS	48	43	13	0	**91**

As shown in table 5-7 the frequency factor (k) value of most of stations of 1-day duration for both in-situ and reanalysis product are less than 5. This shows the frequency factor (k) value of reanalysis products under UBNB are adequately captured the in-situ frequency factor (k) value. Particularly, the k value for the number stations which are less than 5 for GLADS product and in-situ data are nearly the same.

5.2.2 Evaluating the Frequency factor (K) Values of the reanalysis products for a sub basin of UBNB

The table 5-8 shows the number of stations which occurred in the given k value range for 1-day duration of both in-situ and reanalysis products for a sub basin of UBNB.

Table 5-8 Number of stations for the given k value range for a sub basin of UBNB

		No. of Stations for the following K value Range					Captured Reanalysis Product for k<5
Sub Basin.	**Data Source**	**< 3**	**(3 - 5)**	**(5-9)**	**> 9**	**< 5**	
Anger	in situ	1	3	1	0	**4**	All
	ECMWF	0	5	0	0	**5**	
	ECMWF Corr.	2	3	0	0	**5**	
	GLADS	3	2	0	0	**5**	
Belles	in situ	0	1	0	0	**1**	ECMWF
	ECMWF	1	0	1	0	**1**	
	ECMWF Corr.	0	0	2	0	**0**	
	GLADS	2	0	0	0	**2**	
Beshilo	in situ	4	3	0	0	**7**	GLADS
	ECMWF	2	0	5	0	**2**	
	ECMWF Corr.	2	0	5	0	**2**	
	GLADS	3	4	0	0	**7**	
Dabus	in situ	1	4	0	0	**5**	ECMWF & GLADS
	ECMWF	3	2	0	0	**5**	
	ECMWF Corr.	0	0	3	**2**	**0**	
	GLADS	0	5	0	0	**5**	
Didessa	in situ	15	11	2	0	**26**	All
	ECMWF	3	25	0	0	**28**	
	ECMWF Corr.	3	25	0	0	**28**	
	GLADS	19	9	0	0	**28**	
Fincha	in situ	1	1	0	0	**2**	All
	ECMWF	1	1	0	0	**2**	
	ECMWF Corr.	1	1	0	0	**2**	
	GLADS	2	0	0	0	**2**	
Guder	in situ	1	1	1	0	**2**	ECMWF
	ECMWF	0	2	1	0	**2**	
	ECMWF Corr.	2	1	0	0	**3**	
	GLADS	0	3	0	0	**3**	

		No. of Stations for the following K value Range					Captured Reanalysis Product
Sub Basin.	**Data Source**	**< 3**	**(3 - 5)**	**(5-9)**	**> 9**	< 5	
Jemma	in situ	4	4	0	0	8	GLADS
	ECMWF	6	1	1	0	7	
	ECMWF Corr.	4	3	1	0	7	
	GLADS	5	3	0	0	8	
Muger	in situ	3	0	0	0	3	GLADS & ECMWF Corr.
	ECMWF	1	0	2	0	1	
	ECMWF Corr.	1	2	0	0	3	
	GLADS	2	1	0	0	3	
North Gojjam	in situ	6	5	0	0	11	ECMWF & ECMWF Corr.
	ECMWF	11	0	0	0	11	
	ECMWF Corr.	3	8	0	0	11	
	GLADS	1	3	7	0	4	
Rahad	in situ	0	1	0	0	1	GLADS & ECMWF
	ECMWF	1	0	0	0	1	
	ECMWF Corr.	0	0	1	0	0	
	GLADS	0	1	0	0	1	
South GoJjam	in situ	2	3	1	**2**	5	ECMWF Corr.
	ECMWF	3	3	2	0	6	
	ECMWF Corr.	3	2	3	0	5	
	GLADS	5	2	1	0	7	
Tana	in situ	10	7	2	0	17	GLADS
	ECMWF	8	2	9	0	10	
	ECMWF Corr.	4	8	7	0	12	
	GLADS	5	9	5	0	14	
Welaka	in situ	1	0	0	0	1	GLADS
	ECMWF	0	0	1	0	0	
	ECMWF Corr.	0	0	1	0	0	
	GLADS	0	1	0	0	1	
Wonbera	in situ	0	1	0	0	1	GLADS
	ECMWF	0	0	1	0	0	
	ECMWF Corr.	0	0	1	0	0	
	GLADS	1	0	0	0	1	

As table 5-8 shown the of number of stations k values in a sub basin are less than 5 and compered the k value of a sub basin of reanalysis product result with the in-situ result. for ECMWF, ECMWF bias corrected and GLADS products are captured by 10, 7 & 6 number of sub basin respectively. This shows as a sub basin of UBNB GLADS product is adequately captured the k value range with respect to in-situ result.

5.2.3 Computed Maximum Frequency Factor (Km) Values Using Hershfield's Frequency Equation for a Sub Basin of UBNB.

Table 5-9 Frequency factor (Km) Values for a sub basin of UBNB using Hershfield's Frequency Equation.

km-Value Using Hershfield's Frequency Equation for a Sub Basin of UBNB												
	1-day				2-day				3-day			
Sub Basin	In-situ	ECMWF	ECMWF bias Corrected	GLADS	In-situ	ECMWF	ECMWF bias Corrected	GLADS	In-situ	ECMWF	ECMWF bias Corrected	GLADS
Anger	7.755	4.186	4.071	3.370	4.399	4.572	4.451	3.329	3.003	3.750	5.634	3.973
Belles	4.352	5.075	7.627	2.361	7.574	4.353	6.449	2.745	6.127	2.918	6.953	3.300
Beshilo	5.956	6.067	7.926	4.251	2.626	5.378	**9.577**	4.070	2.438	6.205	**10.762**	3.229
Dabus	4.682	3.052	**9.187**	4.956	4.852	2.750	8.859	3.073	4.554	3.286	7.201	4.565
Didessa	8.314	4.324	4.141	3.845	6.480	4.721	3.683	4.295	5.357	5.064	3.344	5.113
Fincha	3.357	3.466	3.085	2.309	4.103	3.362	2.341	2.963	2.825	2.391	2.733	2.173
Guder	7.248	5.046	3.186	3.210	6.187	4.117	3.535	3.092	**9.002**	3.884	4.073	2.392
Jemma	4.184	7.998	6.670	3.715	3.959	6.138	7.550	4.261	4.875	5.857	5.540	3.833
Muger	2.977	5.834	3.935	3.003	2.696	4.713	3.415	3.981	2.796	4.102	4.073	3.232
North Gojjam	4.908	2.953	3.301	**6.558**	6.706	3.429	3.672	**5.771**	8.187	3.753	4.080	**6.008**
Rahad	4.609	2.861	6.622	3.267	4.287	2.826	4.263	4.813	2.851	2.670	2.816	3.214
South Gojam	**10.555**	5.059	5.700	5.273	**8.326**	2.866	4.405	3.246	7.979	3.624	3.958	3.760
Tana	6.435	**8.008**	6.187	5.850	7.397	**8.523**	7.160	**5.771**	6.876	**8.432**	6.379	**6.008**
Welaka	2.799	5.691	7.926	4.410	6.141	2.389	2.993	3.003	6.533	3.624	3.958	2.958
Wonbera	4.087	5.059	5.700	2.870								

According to table 5-8 result, the Km of value for a sub basin of the reanalysis product are not adequately captured Km value of the respective sub basin of the in situ data.

5.2.4 Determination of Frequency Factor (K) Values Using Hershfield's Chart.

A sample station was taken and the Hershfield's chart was used to determine the frequency factor. Since the mean of the annual maximum rainfall series at finoteselam station for in-situ 1-day duration is 50.3 mm, the frequency factor corresponding to the mean from Figure 3-1 (Hershfield's chart) is 17.28.

Using Hershfield's Chart the maximum frequency factors (Km) of 1-day duration for in-situ, ECMWF, ECMWF bias corrected and GLADS are 18.20,17.88,18.393 & 16.910 respectively.

5.2.5 Comparison of the frequency factor (K) Values using Hershfield's frequency equation and Hershfield's Chart.

Generally, the means for the majority of stations in the study area for the indicated duration is found to be less than 100 mm; therefore, there corresponding frequency factors from the chart ranges from 15 to18 which is more than twice of the estimated Km in the above mentioned procedure.

As mentioned in section 5.2.1 the frequency factor embedded in equation 3-2 obtained from the analysis result is 11 for in-situ day duration but using Hershfield's chart this value extends up to 18 so before using this result for further analysis is used for tray to find the inherent causes for under estimation.

One reason of underestimation could be the parent probability distribution of the extreme rainfall series for Ethiopia may be far from the frequency equation given by Hershfield. The frequency equation is standardized in the form of Normal probability type of quantile estimator with mean ($\overline{X}_n$) and Standard deviation (σ_n) the difference which takes care of the distribution difference is the frequency factor Km. But any distribution can be converted to the frequency equation using the frequency factor Km.

Based on the moment and L-moment ratio diagrams described in previous section the candidate distribution for the majority of the stations in the study area

were General Extreme Value (GEV) and Pearson(III). Therefore, frequency factor estimated for some of the above distributions to check whether it is closer to the chart's value or the analysis result.

The relationship between the frequency factor, K and return period, T for different distributions are described by chow (chow, 1953). Taking Pearson (III) distribution as example because, it is found to be a candidate distribution for majority of stations in the study area.

The frequency factor for Pearson (III) distribution expressed as follows in terms of u (standard variate) and Cs (coefficient of skewness).

$$Kmp = \left[\frac{2}{Cs}\right] * \left[\left(\frac{Cs}{6}\right) * \left(U - \left(\frac{Cs}{6}\right)\right) + 1\right]^3 - 1$$

Where U is a standard variate which is a function of return period T

$$u = W - \frac{C_o + C_1 W + C_2 W^2}{1 + d_1 W + d_2 W^2 + d_3 W^3} + \varepsilon(p)$$

Where:

$W = \sqrt{-2\ln(p)}$ *for* $p < 0.5$

$p = 1 - F$

$p = 1 - p$ *for* $p > 0.5$

Co, C1, C2, d1, d2, d3 are constants and $\varepsilon(p)$ is the error term

The following table shows the frequency factor for the stations in the basin fitting Pearson (III) distribution for 10^7 years' recurrence interval.

Table 5-10: Frequency Factors for some of the stations in the basin having statistical values fitting Pearson (III) distribution.

Station No.	Station Name	Coefficient of skewness (Cs)	Frequency factor (kmp).	Station No.	Station Name	Coefficient of skewness (Cs)	Frequency factor (kmp)
1	Abasina Joger	-0.134	4.637	60	Gondar	0.281	6.497
4	Adet	0.739	8.913	61	Gondar A.P.	0.977	10.293
11	Ambo Met	0.844	9.513	66	Jeldu	0.322	6.697
16	Atnago	0.56	7.926	67	Jimma	0.225	6.226
20	Bahir Dar (Airport)	0.255	6.368	71	Lemi	0.53	7.763
23	Baro (Yaya-Hurum)	0.2	6.107	72	Limu Genet	0.612	8.205
29	Chora	0.2	6.107	74	Mehal Meda (RS)	0.288	6.528
39	Dedessa	0.473	7.468	77	Merawi	0.48	7.504
40	Dedessa river	0.374	6.956	78	Merto Lemariam	0.38	6.989
48	Enjabara	0.445	7.322	85	Nekemte	0.931	10.024
49	Felege Berhan	0.929	10.01	100	Yanfa	0.758	9.019
55	Gebre guracha	-1.514	1.391	103	Yetnora	0.507	7.642

The highest value of (Km) for the in-situ 1-day duration obtained in the previous section was 11 which also correspond to about 10^7 years of return period as shown in the above tables. But, the estimates of PMP calculated for stations by practitioners in Ethiopia so far using Hershfield's chart (i.e. Km around15) which corresponds to 10^{11} years return period are very much impractical and beyond the NRC range (100,000-10^9years). It was therefore considered that the use of Km =11 for this study area would give a reasonable estimates of the 1-day PMP rather than using the chart.

5.2.6 Estimation of PMP Using Hershfield's Frequency Equation for the Upper Blue Nile Basin

The point probable maximum precipitation for different stations in the study area were estimated based on the Hershfield's frequency equation using the frequency factor Km values mentioned in the previous section. The PMP value at Finoteselam station for in situ 1-day duration shown in table 5-11 is taken as a sample to show the procedures of PMP estimation. The estimated PMP values

of all the in situ and reanalysis data for 1 day, 2 & 3 days' durations are shown in *Appendix F*

Table 5-11 Procedure for PMP estimation at Finoteselam station for in-situ 1-day durations

No	Descriptions	Symbol	Values	Remarks
1	Station Name	Finoteselam		10.717N,37.05E and 1840 m Alt.
2	Sample Size	N	14	
3	Mean(mm)	Xn	50.3357	
4	Standard Deviation(mm)	σn	9.6171	
5	Mean after Excluding the maximum rainfall depth from the series(mm)	Xn-1	48.8231	
6	Standard deviation after Excluding the maximum rainfall depth from the series(mm)	σn-1	8.09281	
7	The ratio of 5 and 3	Xn-1/Xn	0.96995	
8	The ratio of 6 and 4	σn-1/σn	0.8415	
9	Adjustment of mean for the maximum observed series (see section 2)	From fig(2.2),	1.0304	
10	Adjustment of mean for length of record (see section 2)	From fig (2.4)	1.036	After Hershfield,1961,b
11	Adjustment of standard deviation for the maximum observed series (see section 2)	From fig(2.3)	0.98667	
12	Adjustment of standard deviation for length of record	From fig(2.4)	1.147	
13	Adjusted mean(mm)	adj. mean	53.7331	
14	Adjusted stdev(mm)	adj.stdev	10.8837	
15	Frequency factor	km	11	See section 5.2
16	1-day probable maximum precipitation(mm)	1-day PMP	173.454	
17	24 hrs probable maximum precipitation(mm)	1.13*daily PMP	**196.003**	After Hershfield,1961,b

As shown in the table 5-11 the in-situ 1-day PMP at Finoteselam station is 196 mm. Different adjustments like adjustment for record length were made for different stations in the basin for different durations. The figures in Section Three were used for the analysis (After Hershfield, 1961, b)

The Table 5-12 show below the computed Km and PMP value using Hershfield, equation for both in-situ and reanalysis data for different duration in the study area.

Table 5-12 Km and PMP Result for In-Situ and Reanalysis Data

Data Source	Duration					
	1-Day		2-Day		3-Day	
	Km	PMP (mm)	Km	PMP (mm)	Km	PMP (mm)
In situ	10.555	521.00	8.326	659.984	9.002	874.468
ECMWF	8.008	339.413	8.523	423.087	8.432	408.025
ECMWF with bias corrected	9.187	268.427	9.577	292.095	10.762	319.257
GLADS	6.558	586.421	5.771	661.883	6.008	713.064
Maximum of K & PMP	**10.555**	**586.421**	**9.577**	**661.883**	**10.762**	**874.468**

As shown Table 5-12 for both in-situ and reanalysis data for 1 day, 2 & 3 days the Km and PMP (mm) value not more than 11 and 875 respectively for UBNB. the table also shows GLADS precipitation product adequately capture PMP with respective to the in situ PMP result, and both ECMWF & ECMWF bias corrected reanalysis products are inadequate to capture PMP for this study area so, it needs major data improvement technique. However, the maximum frequency factor (Km) value computed from ECMWF & ECMWF bias corrected products are adequately captured the in situ maximum frequency factor (Km) within the percent of variation range between 2 & 15.

The estimated PMP value for a sub basin of UBNB shown in the table 5-13

Table 5-13 PMP Values for a sub basin of UBNB using Hershfield's Frequency Equation.

PMP (mm) Value Using Hershfield's Frequency Equation for A Sub Basin of UBNB for 1-Day Duration					Present of Deviation		
Sub Basin	In-situ	ECMWF	ECMWF bias Corrected	GLADS	ECMWF	ECMWF bias Corrected	GLADS
Anger	288.010	159.879	94.760	221.822	-44.488	-67.098	-22.981
Belles	198.015	155.286	106.898	220.048	-21.579	-46.015	11.127
Beshilo	178.259	216.494	238.081	427.133	21.449	33.559	139.613
Dabus	254.806	181.607	158.974	324.085	-28.727	-37.610	27.189
Didessa	380.807	208.516	98.682	264.697	-45.244	-74.086	-30.490
Fincha	127.267	132.683	78.108	205.000	4.256	-38.626	61.079
Guder	211.761	119.269	68.785	174.011	-43.677	-67.517	-17.827
Jemma	157.529	191.033	154.201	372.243	21.268	-2.113	136.301
Muger	122.944	138.187	76.015	250.984	12.398	-38.171	104.145
N.gojjam	205.367	117.827	74.230	448.785	-42.626	-63.855	118.528
Rahad	151.477	116.790	95.493	194.621	-22.899	-36.959	28.482
S.gojam	318.053	156.787	89.861	331.805	-50.704	-71.746	4.324
Tana	335.584	234.901	123.190	401.722	-30.002	-63.291	19.708
Welaka	54.407	169.464	175.756	414.192	211.476	223.040	661.287
Wonbera	121.517	127.166	72.364	220.065	4.649	-40.449	81.098

As the result shown in table 5-13, As a sub basin three of them reanalysis products are not adequately captured the PMP values with respective the sub basin of the in-situ PMP value. However, within 25% of deviation ECMWF, ECNWF bias corrected & GLADS Captured by 7, 1 & 5 number of sub basins respectively.

5.2.7 Estimation of PMP Using Hershfield's Chart and Compering the Result with the computed PMP of Hershfield's Frequency Equation.

So far practitioners in Ethiopia have been using the Hershfield's chart for estimation of PMP. Here in this the study estimates of PMP were made alternatively using the chart's Km values to elaborate the discrepancy of the results from the results obtained in the above procedures see the following table for in situ 1-day data.

Table 5-14 Comparison of the resulted PMP with the PMPs from the graphical method

in Situ 1-Day Duration							
Station No.	Station Name	Xm	Adj. mean(Xn) (mm)	Adj. Stdev(σn) (mm)	PMP	PMP By graphical method (mm)	**Percent of deviation**
1	Abasina Joger	70.458	72.601	19.091	319.336	419.645	31.412
2	Abay Sheleko	48.194	48.987	16.263	257.503	344.622	33.832
3	Abdela	63.025	62.436	19.428	312.044	415.606	33.188
4	Adet	50.303	51.212	16.092	257.889	343.739	33.289
5	Agaro	48.139	47.184	11.75	199.377	260.78	30.798
6	Alem Ketema	54.16	54.322	20.336	314.155	423.998	34.965
7	Alibo	49.293	49.797	13.888	228.901	302.259	32.048
8	Amba mariam	42.131	44.807	13.614	219.857	292.288	32.944
9	Ambagiorgis Sch	45.048	46.74	17.587	271.421	366.444	35.009
10	Ambo Agriculture	44.858	46.331	9.798	174.142	224.443	28.885
11	Ambo Met	36.543	36.997	12.742	200.194	268.626	34.183
12	Angerguten	56.156	54.246	16.204	262.712	348.809	32.772
13	Arbgebeya	50.424	51.845	15.977	257.18	342.281	33.09
14	Arjo	56.492	57.445	12.968	226.106	293.182	29.666
15	Assosa	64.309	65.966	19.807	320.737	426.026	32.827
16	Atnago	61.527	62.565	17.714	290.884	384.577	32.21
17	Ayehu	54.972	55.466	18.481	292.398	391.421	33.866
18	Aykel	58.7	59.064	13.686	236.855	307.854	29.976
19	Baco	52.583	54.025	14.104	236.357	310.413	31.332
20	Bahir Dar (Airport)	77.222	80.658	17.885	313.455	405.779	29.454
21	Bahir Dar New	69.6	74.759	22.787	367.721	488.99	32.979
22	Bambase	64.214	64.655	25.912	395.145	535.694	35.569
23	Baro (Yaya-Hurum)	53.058	54.672	12.311	214.802	278.466	29.639
24	Bedele	55.909	56.099	11.418	205.315	263.66	28.417
25	Bullen	71.924	74.01	13.059	245.957	311.402	26.608
26	Chagni	72.092	69.036	20.126	290.421	434.893	**49.746**
27	Chewahit	50.953	54.068	17.867	283.186	378.861	33.785
28	Chira	50.614	52.274	11.063	196.582	253.382	28.894
29	Chora	53.058	54.672	12.311	214.802	278.466	29.639
30	Combolcha	56.322	57.553	12.037	214.653	276.366	28.75
31	Dangila	51.741	52.549	10.715	192.572	247.331	28.435
32	Debark	65.831	65.671	35.945	521.002	719.094	38.021
33	Debena	44.948	44.636	13.941	223.72	298.061	33.23
34	Debre Berhan	47.17	47.548	10.698	186.702	242.021	29.629
35	Debre Elias	44	45.67	8.993	163.393	209.148	28.003
36	Debre Markos	49.273	47.873	12.686	211.781	278.484	31.496
37	Debre Tabor	57.84	57.771	13.904	238.105	310.523	30.415

in Situ 1-Day Duration							
Station No.	**Station Name**	Xm	Adj. mean(Xn) (mm)	Adj. Stdev(σn) (mm)	PMP	PMP By graphical method (mm)	**Percent of deviation**
38	Debre Work	48.482	48.948	11.659	200.232	260.89	30.294
39	Dedessa	69.329	70.191	20.964	339.901	451.283	32.769
40	Dedessa river (Dildy)	59.596	61.602	14.738	252.804	329.515	30.344
41	Dejen	59.846	60.626	16.401	272.378	358.77	31.718
42	Deke Istifanos	79.434	77.16	29.285	451.206	609.514	35.086
43	Dembecha	52.54	54.469	14.217	238.265	312.911	31.329
44	Dengoro	84.75	85.682	30.227	472.544	635.16	34.413
45	Derba	49.744	49.864	19.795	302.398	409.705	35.485
46	Dimtu	48.583	51.222	7.137	146.59	180.961	23.447
47	Enango	58.045	58.976	16.058	266.241	350.885	31.792
48	Enjabara	63.224	63.856	14.886	257.191	334.46	30.043
49	Felege Berhan	59.267	59.837	17.425	284.206	376.596	32.508
50	Feres Bet	63.153	64.154	23.958	370.291	499.672	34.94
51	Fiche	52.224	52.714	14.113	234.994	309.266	31.606
52	Filiklik	40.094	39.393	11.577	188.42	249.844	32.6
53	Finoteselam	50.336	53.733	10.884	196.003	251.587	28.359
54	Gatira	53.153	54.114	10.015	185.635	236.171	27.223
55	Gebre guracha	36.879	40.178	4.631	102.966	124.362	20.78
56	Gembe	52.604	53.341	10.298	188.275	240.542	27.761
57	Gidayana	70.341	72.812	16.999	293.58	381.827	30.059
58	Gimijabet Mariam	57.861	58.015	16.936	276.072	365.884	32.532
59	Gohatsion	54.233	55.146	12.833	221.825	288.429	30.026
60	Gondar	52.175	52.634	12.138	210.354	273.283	29.916
61	Gondar A.P.	54.262	56.694	16.793	272.807	361.964	32.681
62	Gorgora	48.43	49.305	12.298	208.575	272.863	30.822
63	Gundo Woin	59.497	59.604	17.34	282.893	374.817	32.494
64	haike	51.634	54.898	7.402	154.047	189.455	22.985
65	Hamusit	79.197	82.213	22.937	378.003	499.171	32.055
66	Jeldu	41.521	42.784	9.841	170.675	221.678	29.883
67	Jimma	52.86	54.347	10.996	198.094	254.237	28.341
68	Kachis e(Rs)	68.29	67.463	16.547	281.912	368.261	30.63
69	Kelem Meda	61.181	63.577	15.554	265.178	346.324	30.601
70	Kone	66.215	67.853	14.658	229.089	334.308	45.93
71	Lemi	60.468	61.829	16.129	270.349	355.028	31.322
72	Limu Genet	63.296	64.722	14.311	251.02	324.873	29.421
73	Maligawa	52.871	55.482	13.729	233.343	305.053	30.732
74	Mehal Meda (RS)	46.421	47.467	9.901	176.71	227.451	28.714
75	Mekne selam	30.36	33.281	5.312	103.633	129.845	25.293
76	Mendi	77.95	77.555	31.598	480.405	651.956	35.71

in Situ 1-Day Duration							
Station No.	**Station Name**	Xm	Adj. mean(Xn) (mm)	Adj. Stdev(σn) (mm)	PMP	PMP By graphical method (mm)	**Percent of deviation**
77	Merawi	67.85	69.913	17.793	300.166	393.361	31.048
78	Merto Lemariam	38.88	40.134	12.621	202.236	269.564	33.292
79	Meshenti	59.405	62.278	12.739	228.723	293.853	28.475
80	Metema	62.353	62.853	15.447	263.035	343.655	30.65
81	Motta	50.323	51.233	12.934	218.665	286.352	30.955
82	Mukelemi	65.285	66.726	14.967	261.441	338.802	29.59
83	Muletadiga	57.817	57.775	19.373	306.098	409.945	33.926
84	Nefas mewucha	46.969	48.185	3.17	93.855	105.811	**12.738**
85	Nekemte	75.004	75.26	23.161	372.931	496.29	33.078
86	Neshi	63.052	67.037	13.582	244.574	313.936	28.36
87	Nolekaba	64.116	66.549	16.564	281.096	367.656	30.794
88	Pawe	80.943	81.949	21.435	359.034	471.603	31.353
89	Serbo	54.444	55.664	21.189	326.281	440.846	35.112
90	Shambu	51.585	52.081	13.676	228.845	300.689	31.394
91	Shola Gebeya	37.86	41.502	9.515	165.163	214.469	29.853
92	Sibusire	52.821	55.605	12.911	223.317	290.306	29.997
93	Sirinka	54.594	56.397	17.016	275.24	365.721	32.873
94	Tillili	58.804	59.867	11.664	212.628	271.9	27.876
95	Tis_Abay	56.963	57.866	20.884	324.972	437.504	34.628
96	Wegel Tena	44.565	44.487	9.22	164.88	212.092	28.634
97	Werejiru	67.788	69.849	10.084	204.277	253.16	23.93
98	Wereta (Add)	74.177	75.517	24.089	384.757	513.416	33.439
99	Wetet Abay	66.074	65.694	18.512	304.334	402.213	32.162
100	Yanfa	65.804	67.353	18.296	303.524	399.945	31.767
101	Yejubie	44.887	45.672	12.242	203.779	268.212	31.619
102	Yetemen	51.949	51.588	22.08	332.746	452.967	36.13
103	Yetnora	47.825	48.902	10.689	188.122	243.211	29.284
104	Zege	55.253	54.908	19.067	299.043	401.516	34.267

The PMP obtained using the new K value and the chart K values for the stations in the basin shown above table confirms that the PMPs obtained using the K from the chart is greater than range between 13 and 50 % of the PMP obtained using the new K value. Additionally, the Table 5-15 show below the computed Km and

PMP value with respective percent of deviation using Hershfield chart for 1-day both in-situ and reanalysis data in the study area.

Table 5-15 Comparison of the resulted PMP with the PMPs from the graphical method for 1-day in situ and reanalysis data.

Data Source	Duration	Station	Adj. mean(Xn) (mm)	Adj. St.dev(σn) (mm	PMP	frequency factor (Km) for graphical method	PMP By graphical method (mm)	**Percent of deviation**
in Situ	1-Day	32	65.671	35.945	521.002	18.178	719.094	38.021
ECMWF	1-Day	22	58.867	29.809	336.275	17.881	591.897	76.015
ECMWF Bis Corrected	1-Day	69	41.932	21.292	268.427	18.393	433.555	61.517
GLADS	1-Day	84	118.331	61.088	586.421	16.916	1151.727	96.399

As the table 5-15 shown for both 1-day in-situ and reanalysis products the PMP value from Hershfield chart increased by the range between 38 and 96.4 % from that estimated PMP form of Hershfield's Frequency equation. This exaggerated difference of PMP as a result of difference in new Km and the Chart's Km has far reaching consequence in the total cost of dam projects when dam design is considered based on PMF. Therefore, high attention should be provided for the estimation of Km values because, Km constant is sensitive in the estimating PMP.

5.2.8 Comparing the PMP Values with the 10,000 years Return Period Quantiles in the Study Area

According to Hershfield (1962), the magnitude of point PMP at an individual station should normally not exceed three times the Highest Observation Rainfall from a long period of rainfall data. Dhar *et al*. (1981).

Although the PMP has a theoretical exceedance probability of zero, meaning that it is so large that it will never be exceeded, this is not the case in reality. Consequently, a few studies have sought to assign a risk statement to PMP

estimates. The National Research Council (NRC) estimates the return period of the PMP in the United States as between 10^5 and 10^9 years (NRC 1994). Taking these in to consideration the PMP obtained for different stations in the study area compared with their corresponding rainfall Quantiles for T=10,000 years.

The ratio of the PMP values to the T=10,000 years' rainfall Quantiles varies from 0.7 to 3.4 for both in-situ and reanalysis data of different durations. The ratios for the whole stations in the basin are attached in the *Appendix G.*

On average the ratio of PMP values for upper Blue Nile Basin to their corresponding 10,000 years' quantiles are tabulated as follows.

Table 5-16 The ratio of PMP to the 10,000 years return period event

	The ratio of PMP to the 10,000 years quantiles			
Duration	In situ	ECMWF	ECMWF with bias corrected	GLADS
1-day	1.586	1.607	1.780	1.351
2-day	1.726	1.629	1.668	1.244
3-day	1.828	1.603	1.841	1.261

As per the upper mentioned table the ratio of PMP to the 10,000 years return period quantiles for in-situ, ECMWF, bias Corrected ECMWF and GLADS data in the study area are 1.7,1.6,1.8 and 1.3 respectively. This shows ECMWF, ECMWF bias corrected and GLADS reanalysis precipitation product captured the result of average ratio of PMP to the 10,000 years return period quantiles of the in situ data.

5.2.9 Comparing the PMP values of Some of Previous Dam Design Trend in UBNB with this Study Results

As Water works design and supervision Enterprise or WWDSE (2010) the PMP value estimated by Hershfield D.M (1973) for Ribb and Megech dam design and for Gumara irrigation project the design report of WWDSE (2008) shows the frequency factor (K) value taken as a constant of 15. The compared result of

the previous dam design trend in UBNB with the computed PMP value from Hershfield frequency equation are shown in Table 5-17

Table 5-17 Compering PMP value of the previous dam design trend with this study result.

For 1-Day Duration				
From final detail design report, WWDSE (2010) & WWDSE (2008)		Using Hershfield's graphical procedure	Using Hershfield's frequency equation	Percent of deviation
Station used for design of the dams	Size of the data (year)	PMP depth (mm)	PMP depth (mm)	(%)
Debre Tabor (for the Ribb dam design)	1951-2004	295	203	45
Gondar (for the Megech Dam design)	1965-2002	303	214	42
Debre Tabor & Bahir Dar (for Gumara Dam design)		413	319	29

The Table 5-17 result shows the previous dam design of Ribb, Megech & Gumara are overestimated the PMP value by 45, 42 and 29 Percent's respectively this leads to uneconomical dam designs. Therefore, the embedded Km value i.e. 11 is a better to design the reliable PMP value in UBNB.

5.3 Construction of k and PMP Contour Maps for UBNB

Continuous phenomena like precipitation can be graphically represented as contour maps, which are maps in which a set of isolines are interpolated between points of known value. Interpolation is necessary to obtain a spatial pattern because precipitation data typically come in the form of points. However, there are problems of interpolating data between irregularly spaced points of known value. The inverse distance weighting (IDW) is one of the methods to address the upper mentioned problem. IDW lays a grid on top of the input or control points and estimates values at each grid point as a function of distance to each control

point. Then the technique interpolates between the grid points. The control points are weighted as an inverse function of their distance from the grid points.

As shown in figures below the K and PMP contour maps for the in-situ 1-day durations using Hershfield's equation and chart in the study area were constructed using Arc-GIS environment. The inverse distance weighting (IDW) method is used to construct the isolines between two station PMP values.

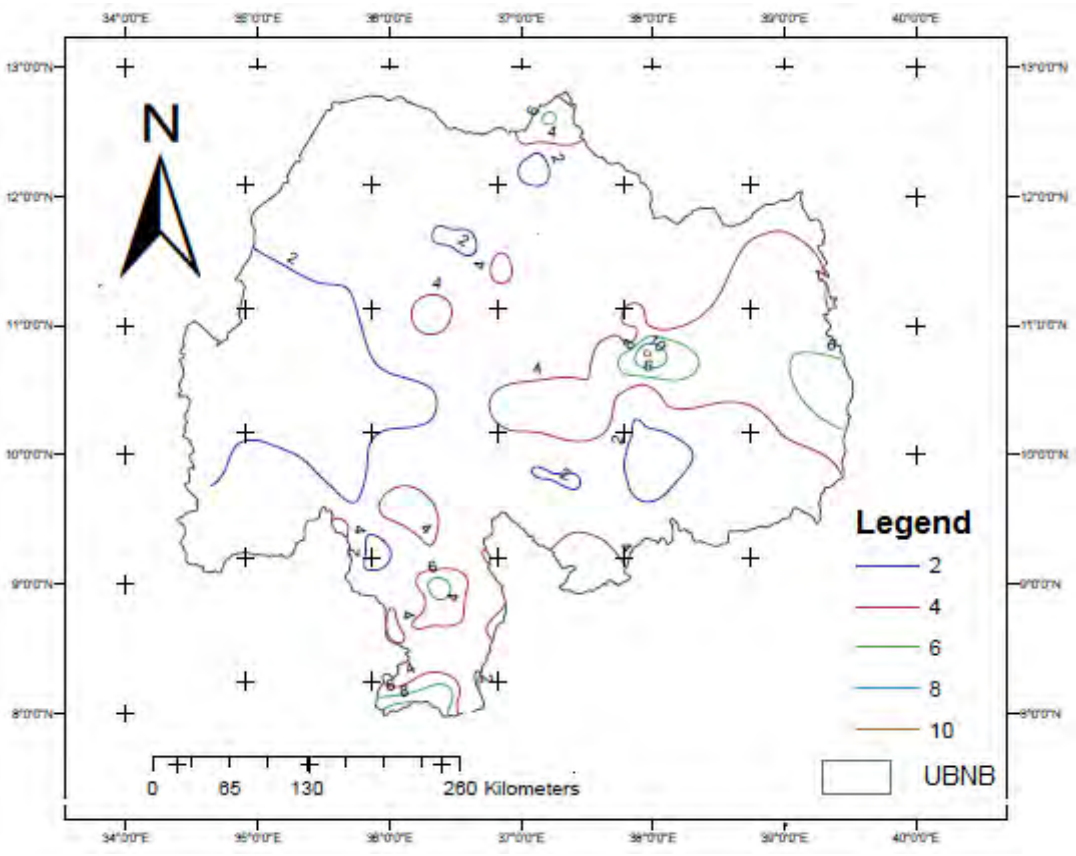


Figure 5-3 Frequency factor (K) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's frequency equation

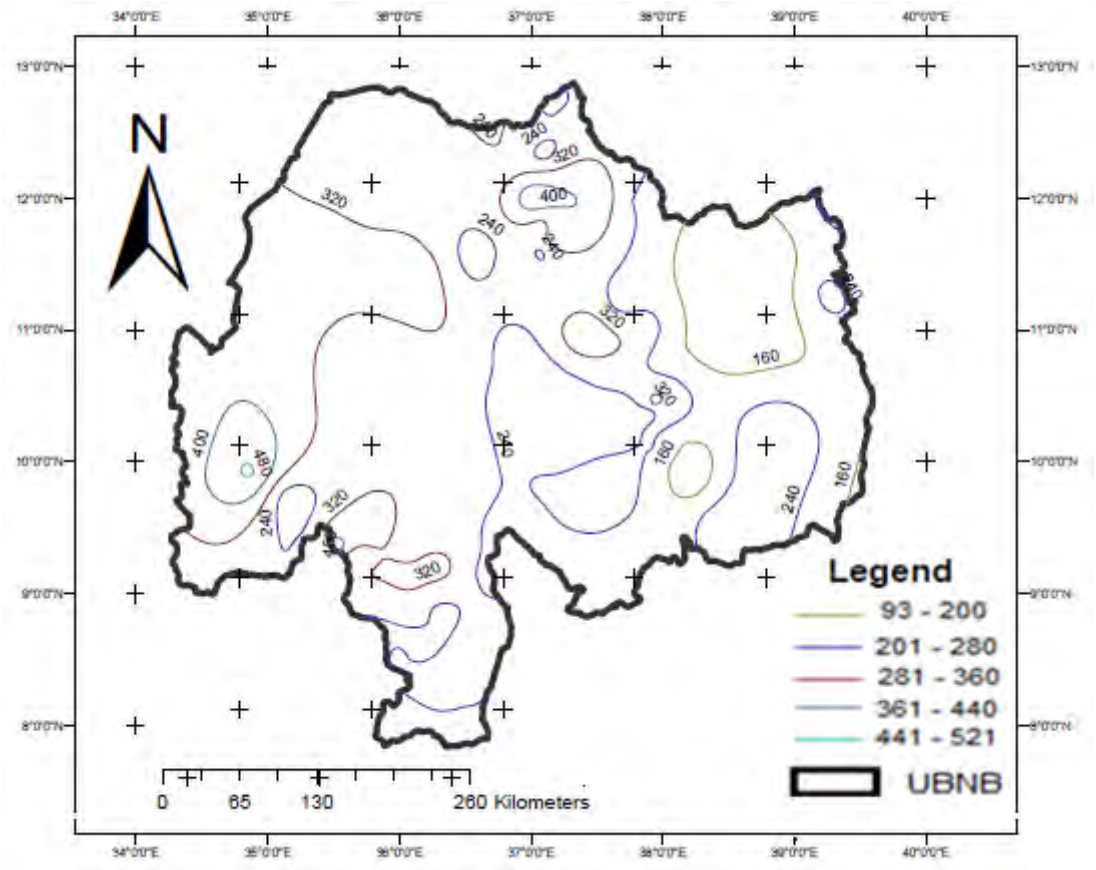


Figure 5-4 PMP (mm) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's frequency equation

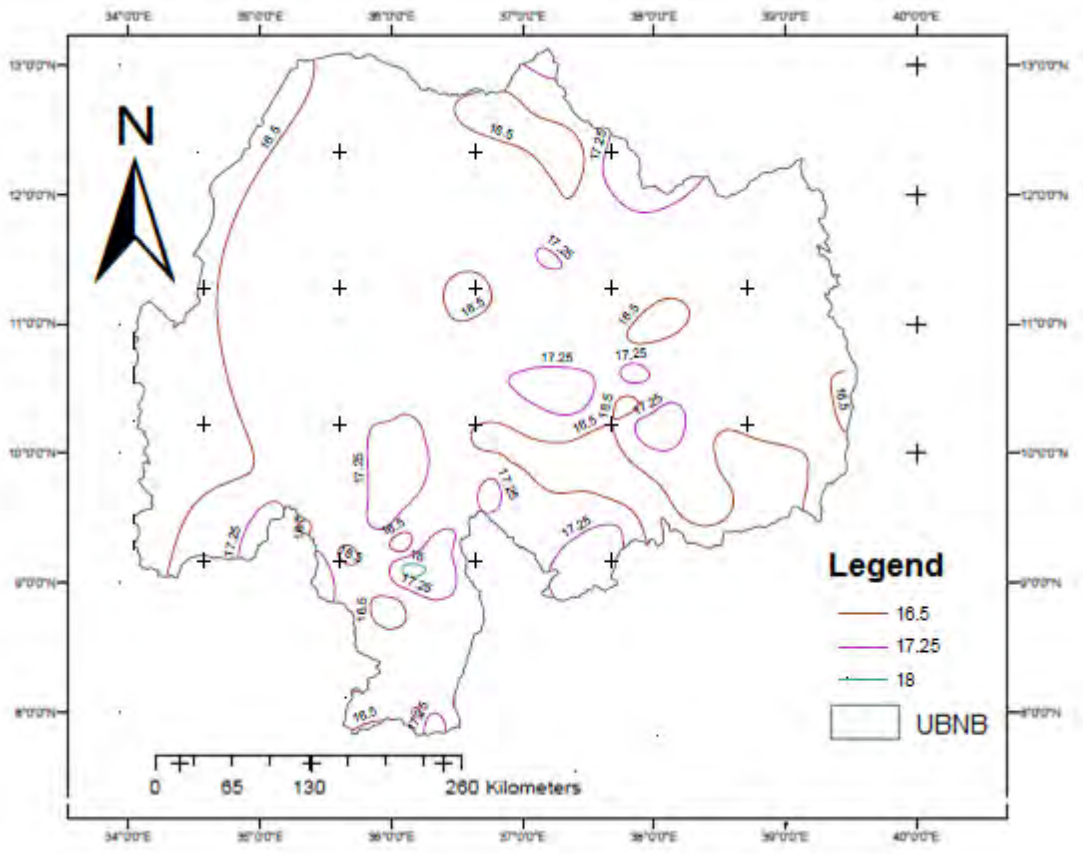


Figure 5-5 Frequency factor (K) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's Chart.

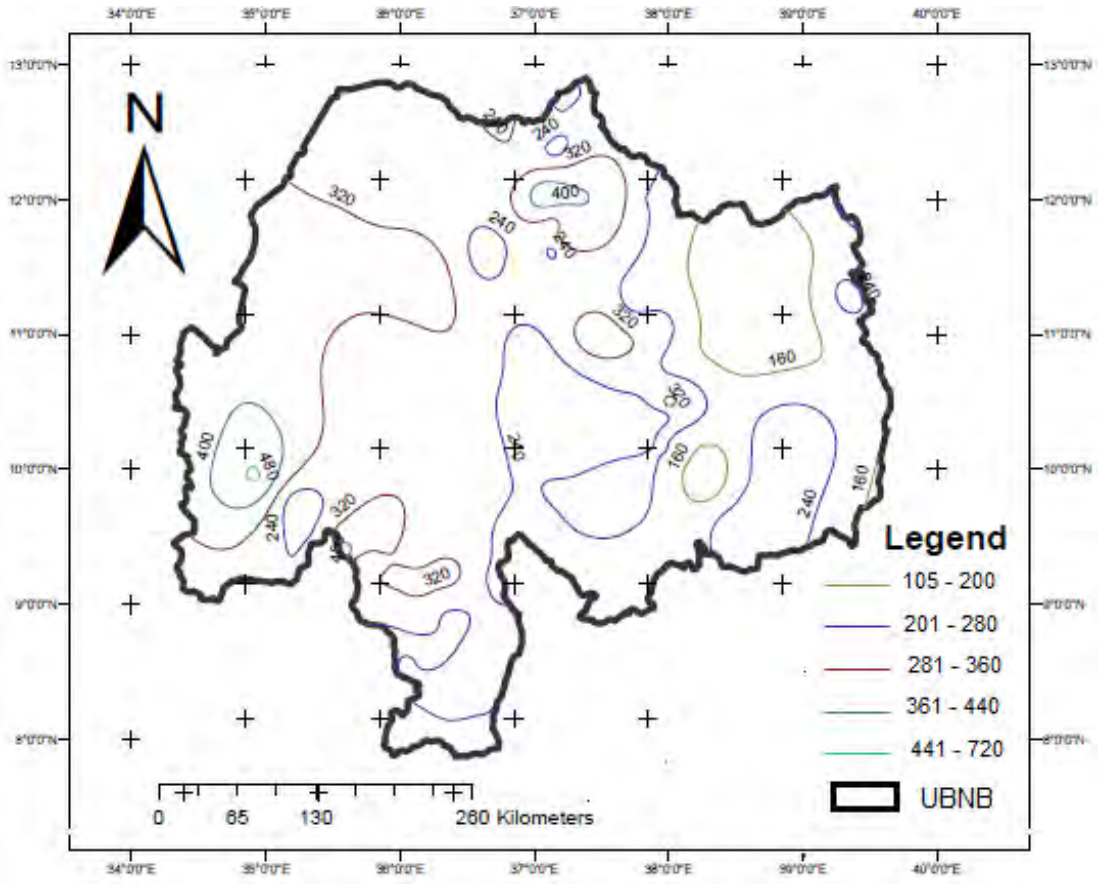


Figure 5-6 PMP (mm) Contour Maps of UBNB for in-situ 1-Day Durations using Hershfield's Chart.

The upper mentioned K and PMP contour map shows the spatial distributions of PMPs over Upper Blue Nile basin. Data from these maps used to characterize the PMP over the Upper Blue Nile Basin. The K and PMP contour maps for the reanalysis products using Hershfield's equation and Hershfield's chart of different durations are sited in the *Appendix H.*

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary and Conclusion

One of the most important problems in Hydrometeorology is the estimation of reliable probable maximum precipitation (PMP) for different durations that are expected to occur over a point or an area. These estimates are of considerable importance to hydrologists for calculating the probable maximum flood (PMF) for planning, design and risk assessment of hydrological structures such as flood control dams upstream of populated areas, and spillways on large dams.

The purpose of this study was to evaluate the frequency factor (Km) embedded in Hershfield's frequency equation of PMP using in-situ & reanalysis precipitation products and refine Km values that would adequately represent the upper Blue Nile Basin and also to evaluate the reanalysis products of K and PMP values of the UBNB for 1 day, 2 & 3 days' durations.

In this study, 104 stations for 1 day and 93 stations for 2 and 3 days' durations were used to estimate new PMP on the basis of statistical procedure.

The methodology chosen for the study area was the statistical method developed by Hershfield (1961, 1965) to estimate PMP based on a general frequency equation given by Chow (1951) for estimating PMP but the statistical value results of the basin were used instead of the Hershfield's chart to determine the values of frequency factor embedded with the equation.

The comparison of the Km value obtained from Hershfield's statistical procedure and the chart is far from each other. While most of the Km values obtained from the chart is between 15 and 18 the maximum Km value obtained using statistical method for both in situ and reanalysis data of 1-day,2 and 3 days' durations are limited to 11.

Similar procedure applied on stations in China (Desa et al. (2001) and M.N. Desa et al. (2003)) and Romania (NIHWM, Bucharest, ROMANIA) to validate the Km value obtained from the chart proved similar trend of lower value.

Using Hershfield equation the estimated Km and PMP (mm) value are not more than 11 and 875 respectively for both in-situ and reanalysis products for all 1 day, 2 & 3 days' durations in UBNB.

For UBNB GLADS precipitation product adequately capture PMP with respective to the in situ PMP result, and both ECMWF & ECMWF bias corrected reanalysis products are inadequate to capture PMP for this study area so, it needs data down scaling or other major data improvement techniques to capture PMP value adequately. However, the maximum frequency factor (Km) value computed from ECMWF & ECMWF bias corrected products are adequately captured the in situ maximum frequency factor (Km) within the percent of variation range between 2 & 15.

When comparing the PMP value as a sub basin, three of them of the reanalysis products are not adequately captured the PMP values with respective the sub basin of the in-situ PMP value this shows the reanalysis products as sub basin of UBNB are not practicable it needs minor and major data improvement techniques. However, within 25% of deviation ECMWF, ECNWF bias corrected & GLADS captured by 7, 1 & 5 number of sub basins respectively.

The estimated PMPs are also corresponds to return periods of up to 10^7 years return period, which is usually acceptable range (NRC,1994) justifying the acceptability of the new Km. Therefore, the new value can be adapted in UBNB also. Comparison of the PMP value using the new Km (Km=11) and the chart values (15-18), exhibited pronounced difference.

The PMP obtained using the new Km value and the chart Km value for the previous dam design of Ribb, Megech and Gumara then the result shows the PMP obtained using the Km from the chart are greater than by 45, 49, and 29 % of the application of new Km value. This difference of PMP as a result of difference in new Km and the Chart Km has far reaching consequence in the total cost of dam projects when dam design is considered based on PMF. Therefore, high attention should be provided for the estimation of Km values.

Furthermore, the average ratio of PMP to the 10,000 years return period quantiles for in-situ, ECMWF, bias Corrected ECMWF and GLADS data in the study area are 1.7,1.6,1.8,1.3 respectively. This shows both ECMWF and GLADS reanalysis precipitation product captured the result of average ratio of PMP to the 10,000 years return period quantiles of the in situ data.

Inaccuracy in PMP estimates result in similar inaccuracy in PMF determination, a risk-based approach to hydraulic design criteria, over estimation of which also results in unwanted economic loss. So far in Ethiopia the frequency factor used for the PMP estimate were made using the Hershfield's chart, but the result of this study shows that these PMP estimates were considerably high and were not therefore, economical. Fresh and reliable estimates are made through this study for the Upper Blue Nile basin.

6.2 Recommendations

According to the results obtained in this research, the following points are recommended:

- Like other country, further researches should be conducted on the rest of basins of Ethiopia for fixing the country's reliable maximum frequency factor (km).
- The PMP developed for a station can be used for areas up to 25 sq. km (according to the WMO guide line). But when the PMP developed at a station is to be applied to an area larger than about 25 sq. km, either the developed PMP contours are used or the point PMP values should be reduced with the help of depth area reduction curves.
- Different country in the world a physically based models are developed to estimate the PMP objectively on the basis of maximization of the physical factors that control the precipitation evolution (Austin et al. 1995, Collier) further researches should be conducted on the application of these models in our country.
- Since the development of the probable maximum flood (PMF) is a powerful tool for practical purposes of water resource developments like in design of spillways to avoid the overtopping of dams as a result of river flooding, it is advisable to develop the PMF for the study area and for the country as well.

7.0 REFERENCES

1. B.D.Kulkarni (2007) Generalized Physical Approach of Estimating Areal Probable Maximum Precipitation (PMP) For Plain Region of the Godavari River Basin (India). Journal Spatial Hydrology Vol.2 No.2
2. B. Ghahraman (2008). The Estimation of One Day Duration Probable Maximum Precipitation Over Atrak Watershed in Iran Iranian, Journal of Science & Technology, Transaction B, Engineering, Vol. 32, No. B2, pp 175-179
3. Bajpai, A.C., Calus, I.M. and Fairley, J.A. (1978). Statistical Methods for Engineers and Scientists. JWSN, London.
4. Bruce, J.P., Clark, R.H., (1996). Introduction to Hydro-Meteorology.New York, Pergamon. p319.
5. Chow, V.T. (ed.) (1964). Handbook of Applied Hydrology. McGraw-Hill Book Company, USA
6. Chow, V.T. (1951). A general formula for hydrologic frequency analysis. Trans. Am. Geophys. Union 32, 231–237.
7. Chow, V.T., Maidment, D.R. and Mays,L.W. (1988). Applied Hydrology. McGRAW, Singapore.
8. Cunnane, C. (1989) Statistical Distributions for Flood Frequency Analysis. World Meteorological Organization Operational Hydrology Report, No.33.
9. D.Alemayehu (2007), A case study on Blue Nile Basin, Msc Thesis in Arba minch University, Arbaminch, Ethiopia
10. Desa M., M.N., Noriah, A.B., Rakhecha, P.R., (2001). Probable maximum precipitation for 24-hr duration over Southeast Asian monsoon region, Selangor, Malaysia. Atmos. Res. 58, 41–54.
11. Desa M., M.N., Sharifuddin, S., Rakhecha, P.R., (2003). To estimate 24-hour probable maximum precipitation for the Malaysian state of Kelantan. Int.Water Power Dam Constr. 35–39 (November issue).
12. Dhar O.N, A.K. Kulkami and P.R. Rakhecha, 1981. Probable maximum point rainfall estimation for the southern half Indian peninsuala, Proc.indian, Academy of science, Banglore 90(1).

13. European Centre for Medium-Range Weather Forecasts (ECMWF) Available [on line] http://www.ecmwf.int/
14. F. Nobilis , T. Haiden 2, and M. Kerschbaum ,(1990) ,Statistical Considerations Concerning Probable Maximum Precipitation (PMP) in the Alpine Country of Austria
15. Global Land Data Assimilation System (GLDAS) Available [online] http://disc.sci.gsfc.nasa.gov/service/grads-gds/glads
16. Hansen, E. M., Schwarz, F. K. and Riedel, J. T., (1977): Probable maximum precipitation estimates: Colorado river and Great Basin drainages. Hydrometeorological Report, No. 49. U.S. National Weather Service.
17. Hershfield, D. M. (1961a) Estimating the probable maximum precipitation. J. Hydraul. Div. ASCE 87 (HY5), 99-116.
18. Hershfield, D. M. (1961b) Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods, 1 to 100 years. US Weather Bureau Tech. Pap. no. 40, Washington DC.
19. Hershfield, D. M. (1965) Method for estimating probable maximum rainfall. J. Am. Wat. Wks Ass. 57, 965-972.
20. K. Fernando and S. Wickramasuriya (2010) The hydro-meteorological estimation of probable maximum precipitation under varying scenarios in Sri Lanka. International Journal of Climatology,31, (668–676).
21. M.C.Casas, R.Rodrıguez Marc P. Antonio G´azquez and A. Redano (2010) Estimation of the probable maximum precipitation in Barcelona (Spain). International Journal of Climatology, DOI: 10.1002/joc.2149.
22. M.N. Desa M., P.R. Rakhecha Probable maximum precipitation for 24-h duration over an equatorial region: Part 2-Johor, Malaysia
23. Ministry of water Resources, Lake Tana Sub-basin four dams project Ribb (August,2007), Gumara (February,2008) and Megech (January, 2008) dam design Feasibility Reports, Volume III.
24. Ministry of water Resources, Lake Tana Sub-basin four dams project Ribb (February,2010) and Megech (February,2010) Final Detail Design Reports, Volume V.

25. National Research Council, (1988, 1994)., Estimating Probabilities of Extreme Floods, Methods and Recommended Research", ISBN 0-309-03791-3, National Academy Press, Washington, D.C. p 141.
26. Rao, K.H, & Hamed, A.R. (2000). Flood Frequency Analysis. CRC press LLC, Florida
27. Simona Matreata, National Institute of Hydrology and Water Management (NIHWM), Bucharest Dynamic-Statistical Model for the determination of PMF, ROMANIA
28. Sine, A. (2004). Regional Flood Frequency Analysis for Blue Nile River Basin, Ethiopia, Msc Thesis. Arbaminch University, Arbaminch, Ethiopia.
29. US. Weather Bureau, (1970). Probable maximum precipitation, Mekong river basin., Hydromet. Report No. 46, Silver spring, Md.
30. U.S. National Weather Service's Hydrometeorological Design Studies Center, website http://www.nws.noaa.gov/oh/hdsc.
31. US Weather Bureau (1961) Generalised estimates of PMP and rainfall frequency data for Puerto-Rico and Virgin Islands. Tech. Paper no. 42.
32. Vincenzo Levizzani (2008) Assessment of Global Precipitation Products http://www.researchgate.net/publication/257029400
33. World Meteorological Organization (WMO), 2009. Manual for estimation of probable maximum Precipitation, W.M.O. No. 1045.
34. World Meteorological Organization, 1986: Manual for Estimation of Probable Maximum Precipitation. Operational Hydrology Report No. 1, WMO–No. 332, Geneva.

APPENDIXES

APPENDIX A: Available Meteorological Stations Used for Upper Blue Nail Basin

No.	Name of Stations	Zone	Elevation	Longtude	Latitude
1	Abasina Joger	Mirab Wellega	1800	36.000	9.033
2	Abay Sheleko	Misrak Gojjam	1823	38.157	10.113
3	Abdela	Illubabor	1942	36.233	8.367
4	Adet	Mirab Gojjam	2179	37.493	11.275
5	Agaro	Jimma	1666	36.600	7.850
6	Alem Ketema	Semen Shoa	2280	39.033	10.033
7	Alibo	Misrak Wellega	2513	37.074	9.886
8	Amba mariam			38.467	11.750
9	Ambagiorgis Sch	Semen Gondar	2900	37.600	12.767
10	Ambo Agriculture	Mirab Shoa	2068	37.840	8.985
11	Ambo Met			37.850	8.983
12	Angerguten			36.333	9.267
13	Arbgebeya	Misrak Wellega	1860	36.750	9.050
14	Arjo	Misrak Wellega	2565	36.500	8.750
15	Assosa			34.520	10.070
16	Atnago	Jimma	1847	36.983	8.300
17	Ayehu	Awi	1771	36.793	10.661
18	Aykel	Semen Gondar	2254	37.059	12.540
19	Baco	Mirab Shoa	1650	37.083	9.117
20	Bahir Dar (Airport)	Mirab Gojjam	1827	37.322	11.603
21	Bahir Dar New	Mirab Gojjam	1800	37.385	11.595
22	Bambase	Assossa	1460	34.733	9.750
23	Baro (Yaya-Hurum)	Illubabor	1700	36.900	7.967
24	Bedele	Illubabor	2011	36.333	8.450
25	Bullen	Metekel	1659	36.082	10.596
26	Chagni	Awi	1614	36.499	10.974
27	Chewahit	Semen Gondar	1925	37.228	12.335
28	Chira	Illubabor	2095	36.233	7.733
29	Chora	Illubabor	2090	36.117	8.350
30	Combolcha	Debub Wollo	1857	39.718	11.084
31	Dangila	Awi	2116	36.846	11.434
32	Debark	Semen Gondar	2836	37.898	13.142
33	Debena	Illubabor	1930	36.283	8.400
34	Debre Berhan	Semen Shoa	2750	39.500	9.633
35	Debre Elias	Gojam	2140	10.300	37.470
36	Debre Markos	Misrak Gojjam	2446	37.739	10.326

…….Cont'd Available Meteorological stations used for UBNB					
37	Debre Tabor	Semen Gondar	2612	37.995	11.867
38	Debre Work	Misrak Gojjam	2508	38.162	10.651
39	Dedessa	Misrak Wellega	1310	36.100	9.383
40	Dedessa river (Dildy)	Illubabor	1295	36.400	8.683
41	Dejen	Misrak Gojjam	2448	38.151	10.171
42	Deke Istifanos	Mirab Gojjam	1815	37.226	11.873
43	Dembecha	Mirab Gojjam	2117	37.486	10.566
44	Dengoro	Mirab Wellega	1900	35.733	9.200
45	Derba	Semen Shoa	2385	38.651	9.426
46	Dimtu	Jimma	1780	37.233	7.850
47	Enango	Mirab Wellega	1800	35.683	9.167
48	Enjabara	Awi	2568	36.919	10.995
49	Felege Berhan	Misrak Gojjam	2710	38.067	10.743
50	Feres Bet	Mirab Gojjam	3000	37.609	10.850
51	Fiche	Semen Shoa	2784	38.733	9.767
52	Filiklik	Semen Shoa	1853	38.243	10.053
53	Finoteselam	Mirab Gojjam	1840	37.050	10.717
54	Gatira	Illubabor	2358	36.200	7.983
55	Gebre guracha			38.400	9.800
56	Gembe	Jimma	1596	36.667	7.833
57	Gidayana	Misrak Wellega	1850	36.617	9.867
58	Gimijabet Mariam			35.833	9.167
59	Gohatsion	Semen Shoa	2507	38.240	10.004
60	Gondar	Gonder	1967	12.550	37.420
61	Gondar A.P.	Semen Gondar	1973	37.432	12.521
62	Gorgora	Semen Gondar	1830	37.300	12.250
63	Gundo Woin	Misrak Gojjam	2052	38.089	10.929
64	haike			39.667	11.300
65	Hamusit		1900	37.380	11.770
66	Jeldu	Mirab Shoa	2952	38.083	9.250
67	Jimma	Jimma	1718	36.817	7.667
68	Kachis e(Rs)	Mirab Shoa	2520	37.860	9.583
69	Kelem Meda	Debub Wollo	2500	39.517	11.183
70	Kone		2000	36.783	8.683
71	Lemi	Semen Shoa	2500	38.900	9.817
72	Limu Genet	Jimma	1766	36.950	8.067
73	Maligawa		1800	36.917	8.100
74	Mehal Meda (RS)	Semen Shoa	3084	39.660	10.315
75	Mekne selam			38.750	10.750
76	Mendi	Mirab Wellega	1650	35.100	9.783

…Cont'd Available Meteorological stations used for UBNB					
77	Merawi	Mirab Gojjam	2000	37.164	11.411
78	Merto Lemariam	Misrak Gojjam	2676	38.280	10.880
79	Meshenti			37.284	11.473
80	Metema	Semen Gondar	790	36.414	12.775
81	Motta	Misrak Gojjam	2417	37.890	11.074
82	Mukelemi	Mirab Wellega		35.533	9.333
83	Muletadiga	Mirab Wellega	2130	36.483	8.950
84	Nefas mewucha			38.467	11.734
85	Nekemte	Misrak Wellega	2080	36.463	9.083
86	Neshi	Misrak wellega	2060	37.268	9.723
87	Nolekaba	Mirab Wellega	1800	35.833	8.950
88	Pawe	Metekel	1119	36.410	11.312
89	Serbo	Jimma	1792	36.967	7.700
90	Shambu	Misrak Wellega	2460	37.121	9.571
91	Shola Gebeya	Mirab Shoa	2500	39.550	9.218
92	Sibusire	Misrak Wellega	1826	36.872	9.040
93	Sirinka			39.600	11.750
94	Tillili			37.021	10.251
95	Tis_Abay	Mirab Gojjam	2642	37.579	11.488
96	Wegel Tena	Semen Wollo	2952	39.221	11.590
97	Werejiru	Mirab Wellega	1800	35.367	9.617
98	Wereta (Add)	Debub Gondar	1819	37.696	11.922
99	Wetet Abay	Mirab Gojjam	1920	37.042	11.370
100	Yanfa	Illubabor	2080	36.600	8.233
101	Yejubie			37.750	10.150
102	Yetemen	Misrak Gojjam	2418	38.147	10.329
103	Yetnora	Misrak Gojjam	2420	38.108	10.245
104	Zege	Mirab Gojjam	1801	37.312	11.689

APPENDIX B: Available in Situ and Reanalysis Data for 1 day, 2 and 3 days' durations

Table B.1 Annual Maximum Rainfall of in-situ data for Different Stations in UBNB (mm)

Abay Sheleko

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1984	38.3	61.7	78
1985	40.3	59.7	66
1986	57	98	112.5
1987	44	54.1	65.3
1988	58	67.5	90.6
1989	52.6	61.4	72.4
1990	41.1	42.3	58.3
1993	30.4	50.7	60.9
1994	36.2	61.5	85.5
1995	40	49.4	73.2
1996	43.2	81.1	115.8
1997	69.8	79.2	115.1
1998	49.2	64	88.5
1999	50.6	70.8	71.9
2000	54.5	66.3	79.1
2001	54.4	68.1	80.5
2002	52.4	85.2	104.5
2003	51.1	66.4	85.2
2004	58.4	82.1	116.4
2005	53.8	71.1	94.6
2006	42.3	63.4	103.6
2007	81.2	101.2	103.5
2008	45	76.7	95.1
2009	50.9	80.8	93.2
2010	43.7	53.7	70.9
2011	78.9	101.2	115.5
2012	72	100.6	112.8
2013	30.5	60.5	84.5
2014	32.5	39.4	53.7
2015	35.5	60.8	60.8

Abdela

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	58.4	104	117.2
1987	67	77	130
1988	96.4	124.3	158.7
1989	69.5	82.1	115.1
1990	50	76	113.3
1991	60.2	81.4	101.5
1992	62.1	90.7	105.2
1993	60.5	91.5	91.5
1994	49.3	67	82
1995	42.5		
1996	57.8	70.2	78.9
1997	63.6	79.2	93.8
1998	39.6	70.3	91.9
1999	46	97.8	123.1
2000	94.7	73	93.3
2001	48.4		
2002	40.5	51.6	73.2
2003	38.3	58.5	67
2004	60.6	107.9	125.5
2005	67.4	86.5	92.8
2006	57.6	78.8	88.8
2007	142.3	143.3	143.5
2008	42.4	68.3	74.7
2009	60.7	99.4	112
2012	46.6	104.8	150.7
2013	97.3		
2014	72.6	87.6	87.6
2015	72.4		

Adet

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	31.2	90.1	125.7
1987	42.6	55.1	73.7
1988	76.1	80.3	86
1989	79.5	103.5	114
1990	37.8	57.2	71.7
1991	53.9	76.5	93.7
1992	64.7	80.2	98.7
1993	41.5	62.3	75.6
1994	43.6	67	76.7
1995	64.5	103.9	122.9
1996	56.3	61.1	75.2
1997	56.6	70.2	80.6
1998	81.9	113.1	118.4
1999	40.3	59.3	75.2
2000	35.8	45.5	51.3
2001	46.7	65.5	77.6
2002	46	54	59.5
2003	43.6	60.4	72.1
2004	35.6	62.8	65.6
2005	53.8	60.6	71.6
2006	70.2	93.5	97.5
2007	34.2	56.6	79
2008	65.9	90.6	112
2009	38	59.5	75.5
2010	35.4	64.5	76.5
2011	69.5	81.5	83.3
2012	37.1		
2013	38.8	69.1	73.3
2014	49.5	50.9	61.7
2015	38.5	46.7	49.9

Agaro

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1995	48.4	91.2	121.3
1996	46.2	80.1	94.9
1997	45.3	73	97.3
1998	46.2	73	95.9
1999	25.4	46.2	58.8
2000	35.8	56.2	75.7
2001	42.5	44.8	53.2
2002	48.9	61.5	85.2
2003	34.3	68.1	97.3
2004	63.6	67.5	69.6
2005	40	49.5	73.7
2006	44	62.5	72.5
2007	49.2	66.2	72.4
2009	33.5	53.4	61.6
2013	58.6	81	121.3
2014	44.6	68.6	91
2015	40.3	70.4	91.3

Alem Ketema

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1980	110.8	135.3	157.8
1981	80.9	126.1	128.5
1982	76	80.2	95.7
1983	63.5	63.5	80.3
1984	31.4	52.7	63.5
1985	66.3	76.1	85.6
1986	51.2	90.1	125.7
1987	42.8	57.4	68.6
1988	65.9	112.1	146.7
1989	74.5	109.5	155.1
1990	14.4	17.6	24.2
1991	42.5	67.2	89.4
1992	103.4	103.4	104.4
1993	43.9	56.1	81.5
1994	54.8	59.9	75.1
1995	32.6	44.7	61.7
1996	82.7	100.9	118.9
1997	54.0	89.9	116.2
1998	47.3	60.1	70
1999	44.1	65.5	90.3
2000	50.2	80.7	97.1
2001	47.2	71.5	86.8
2002	55.8	78.1	86.3
2003	51.3	74.4	87.1
2004	38.3	47.3	66.7
2005	47.5	61.8	82.9
2006	45.6	59.3	73.3
2007	65.3	71.9	91.3
2008	35.5	62.8	69.1
2009	48.9	60.8	75.6
2010	42.7	50.2	88.5
2011	39.7	54.1	64.9
2012	63.3	74.7	76.7
2013	35.0	60.4	66.9
2014	46.3	78.6	120.5

Alibo

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	52.4	75.1	87.6
1987	52.4	84.1	103
1988	41.5	82.1	97
1989	51.4	52.4	63.3
1990	48.6	88.2	92.9
1991	54.1	70.5	85.1
1992	41.6	63.3	87.9
1993	38.8	57.4	73.8
1994	38.3	47.2	65
1995	51.8	66.3	76.2
1996	49.5	63.3	72.3
1997	33.6	58.1	75.8
1998	58.9	85.4	85.4
1999	41.8	51	64.1
2000	36.6	57.1	68.2
2001	48.8	64.2	67.6
2002	68.4	74.9	86.5
2003	88.7	97.4	128.2
2004	58.8	80.4	86
2005	25.7	91.8	119.2
2006	39.6	72.1	81
2007	47.6	56.9	81
2008	78.3	91.8	119.2
2009	58.7	82	82
2010	63.2	63.5	74.4
2011	43.9	58.7	85.7
2012	29.7	57.1	67
2013	53.8	58.3	72.1
2015	33	40.6	50.1

Ambagiorgis Sch

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1984	43.2	46.4	46.4
1986	36	49.5	58.3
1987	46	66.5	73.9
1988	100.6	109.2	116.9
1989	28.4	40.4	45.7
1990	26	32.4	47.9
1992	83.7	90	90
1993	46	50.8	53.5
1994	30.7	51.7	61.1
1995	36.4	63	81.6
1996	33.6	49.1	62.6
1997	43.1	69.4	79.9
1998	50.3	65.2	91.8
1999	39.5	55.6	63.7
2000	58.5	68.5	72.9
2001	36.2	60.8	73.6
2002	44.2	82.1	88.7
2003	45.6	64.9	100.2
2004	30.9	43.4	53.3
2005	41.8	48.1	59.1
2006	43	74.3	89.6
2007	80.4	92.1	103.6
2008	48.7	67.1	76.9
2009	35.7	52.9	63.9
2010	30.2	51.3	70.7
2011	50.2	94.7	137.5
2013	32.3	59.5	74
2014	42.6	65.6	83.1
2015	42.6	54.3	70.1

Ambo Agriculture

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	45	46.1	52.4
1987	43.5	66.8	87
1988	81	81	103
1989	40	49.8	53.8
1990	66.8	74	74.6
1993	38.6	33.9	34.7
1997	37	37.5	54.6
1998	44.5	44.5	44.5
1999	28.9	40.5	48
2000	49	49	57.4
2001	48.9	70.3	74.2
2002	31.2	37.3	48.7
2003	57.1	79.2	81.5
2004	28.1	39	49
2005	37.3	63.5	65.5
2006	49	54.3	73
2007	44.6	73	86.2
2008	47.2	53.6	68.7
2009	36	48	61.2
2010	39	44.7	65.5
2011	45.5	76.5	113
2012	48.6	55.5	62.4
2013	45.5	58	63.6
2014	44.3	56.2	59.2

Arbgebeya

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1988	58	65.2	79.1
1989	38	48	61.2
1990	48.6	89.4	109.4
1991	41.9	72	107.5
1992	48.1	88	124.6
1993	39.7	73.6	90.7
1994	31.5	45.6	52.2
1995	72.1	101.9	105.4
1996	51.6	57.2	76.8
1997	61.1	69.9	83.2
1998	42.7	66.2	70.9
1999	62.6	68.6	69.2
2000	66.8	75.1	83.2
2001	43.7	61.1	81.1
2002	38.8	52.1	67.4
2003	69	84.2	107.2
2004	79.2	88.3	90
2005	77.8	90.3	90.3
2006	38.5	59.8	79.2
2007	28.7	40.8	44.1
2008	44.5	71.9	106.4
2009	48.6	91.1	93.6
2011	44.1	57.2	61
2014	52.1	66.6	74.3
2015	32.9	53.8	64.3

Arjo

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1989	51	66	89
1990	57.9	62.1	83.8
1991	52.8	69.6	89.6
1992	70.3	73.1	109.7
1993	53	63	78.5
1994	48.4	87	123.4
1995	41.3	51	69.1
1996	81.6	109.5	129.3
1997	59.4	93	95.2
1998	42.6	74.7	77.5
1999	44.4	58.6	72.3
2000	99	105.6	143.3
2001	50.5	56.1	70.8
2002	55	58.2	89.8
2003	40	56.6	64.6
2004	46.6	66.8	87.1
2005	36.2	61.4	71
2006	58.4	92.6	110.1
2007	63.2	91.5	112.1
2008	56.3	85.3	106.1
2009	73.2	135.7	141.2
2010	64.6	76.2	103.9
2011	66.4	86.7	109.5
2012	49.9		
2014	58.2	89	106.8
2015	48.6	83.2	100

Debre Markos

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1954	41.8	60.9	74.9
1955	44.2	47.9	75.8
1956	55	72	97.2
1957	35.8	63.9	92
1958	40.9	62.9	92.5
1959	49.7	69.8	80.8
1960	57	78	93.2
1961	46.4	64.7	74.9
1962	52.5	79.2	107.2
1963	44.5	71.1	84.4
1964	57.1	63.3	78.8
1965	35.1	64.9	69.4
1966	37.5	60.1	75.2
1967	50.3	55.9	74.7
1968	41.4	70.3	83.3
1969	43	64.2	86.7
1970	170	176.5	185.5
1971	51.8	74	95.4
1972	43.4	63.6	74.8
1973	38.3	50.7	68.9
1974	42	51.7	67.7
1975	48.5	81.3	83.7
1976	43.6	54.6	61.8
1977	35.1	60.1	63.6
1978	37.6	45	53.6
1979	41.3	56	75.2
1980	37.4	62.1	83.2
1981	39.4	64	81
1982	43.4	68.4	71.4
1983	42.5	62.4	71.1
1984	34.5	47.6	67.2

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1985	78	87.9	97.5
1986	46.6	69.4	76.1
1987	42.6	64.4	84.4
1988	62	70.7	82.7
1989	50	60.5	90.5
1990	56.1	65.3	75.4
1991	49.2	68.7	75.5
1992	41.1	48	61.8
1993	61.3	73.4	85.8
1994	58.4	89.1	92.5
1995	34.6	48.5	77.7
1996	44.8	81.6	84.1
1997	86.9	99.7	114.2
1998	34.5	40.2	59.1
1999	35.9	61.4	78
2000	57.3	88.6	98.6
2001	85.7	106.8	121.4
2002	50.7	75.4	88.8
2003	57.1	67.5	101.9
2004	58.3	72.8	87
2005	38.7	42.7	62.3
2006	38	64.4	88.8
2007	33.1	58	83.5
2008	41.9	61	89.5
2009	52.6	72.3	81.8
2010	55	74.5	79.5
2011	63.5	73.5	80.6
2012	47	78	82.3
2013	36.7	55.9	83.4
2014	41	51.1	75.5
2015	35.3	44.6	58.5

Assosa

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1978	78.3		
1979	44		
1980	60.3	80.3	85.6
1981	46.8	61.2	81
1983	74.5	74.5	76.2
1984	45.9	63	70.6
1985	41.8	60.6	64.1
1986	57.6	61.2	71.4
1987	57.8	66.8	77.4
1988	56	85.8	93.8
1989	69.2	69.7	70.1
1994	56.8	81.5	84.8
1995	65.9	87.8	89.7
1996	41.2	42.8	51.5
2000	93	113	130
2001	99		
2002	54.3		
2003	51.3		
2004	63		
2005	74		
2006	81.6		
2007	102.5		

Atnago

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	40.6	44.8	66.8
1987	66.4	98.5	124.5
1988	105.6	86.3	96.3
1989	57	147.6	190.8
1990	41.3	100.6	122.6
1991	39.3	72.6	98.6
1992	86.5		
1993	67	90.4	134.3
1994	66.1	90.4	103.4
1995	54	89.9	125.4
1996	74.1	106.9	134.6
1997	67.1	101.2	160.5
1998	79.2	81.5	103.5
1999	62	85.2	103
2000	51.7	86	129
2001	52.5	109.1	134.9
2002	60	93.3	120.7
2003	33.5	87.6	105.8
2004	46.8	91.7	132.6
2005	40.6	81.7	112.3
2006	48.2	85.7	108.7
2007	89.3	88.5	99.9
2009	65.5	155.2	178.4
2010	68.8	109.5	116.5
2014	68.8	110.2	121.8
2015	67.8	89.2	120.3

Aykel

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1968	76	88	100.5
1969	65	65	78
1971	42.7	61.5	80.5
1972	36.5	50.1	66.4
1973	57.7	78.2	94.6
1974	67.7	121.8	147
1975	64.2	100.3	144.4
1977	69.8	119.9	179.4
1978	65.7	117.2	169.8
1979	107.1	192.2	251.8
1980	81.2	96.6	130.1
1981	42.8	76.6	100.2
1982	65.4	72.1	91.1
1985	82.7	82.7	89
1986	56	77.3	108.5
1987	62.5	71.4	84.7
1988	51.4	60.8	78.2
1989	42.6	77	84.1
1990	55	76.7	89.9
1991	59.7	62.1	71.7
1993	66.5	78.6	78.6
1994	76.4	76.6	91.2

Angerguten

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	125.0	131.7	134
1987	60.0		
1988	50.5	80.5	107.5
1989	50.0	79.1	122.7
1990	41.6	73.3	99.9
2006	27.9	53	57.1
2009	56.0	96	124
2010	51.4	73.8	73.9
2011	43.0	73	97

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1995	45.6	69.4	90.3
1996	62.8	76.3	79.9
1997	66.1	70.5	88.1
1998	65	99	103.4
1999	47.2	56.1	76.3
2000	48.8	58.8	74.3
2001	44.2	75.5	79
2002	39.2	53.1	73.1
2003	43.8	65.4	71.5
2004	52.1	63.1	72
2005	51.7	61.7	64.4
2006	62	91.6	108.3
2007	56.8	62.2	93.3
2008	45.6	56.9	72.6
2009	84	138	154.5
2010	59.8	75.5	84
2011	58.5	89	92.2
2012	56	91	95.2
2013	49.6	70.9	79.5
2014	54	80.2	80.2
2015	36.7	47.1	79

Bahir Dar New

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
2003	39	85.7	101.2
2004	77.5	137.1	163.1
2005	87.1	117.8	136.3
2006	85.7	82	94.5
2007	74.1	88.8	98.7
2008	68.3	90.2	102.4
2009	64.5	82	97.4
2010	58.1	79.4	91.5
2011	72.8	128.7	161.3
2012	96.7		
2013	86.4	98.6	110.4
2014	48.2	87	99.4
2015	46.4	83.6	99.6

Ayehu

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1990	47	74	79.1
1992	40.8	69.5	73.3
1993	35.3	52.5	66.9
1994	39.6	56.7	63
1995	44	51.6	66.1
1996	81.1	90.8	125.8
1997	58.4	102.2	138.8
1998	58.3	66.7	83.9
1999	47	56.3	68.8
2000	81.2		
2001	106.4	111.7	111.7
2002	33.6	45.4	56.8
2003	39.5	68.1	68.6
2004	45	50	56.4
2005	71.9	84.6	92.1
2006	42.1	51.5	61.6
2007	75	84.5	86.2
2008	44.6	48.6	56.3
2009	64.2	69.6	76.5
2010	39.8	41.3	45.9
2011	50.5	52	59.3
2012	69	89.9	101.7
2013	57.8	65.8	71.5
2014	31.5	53.3	65.4
2015	70.7	89.9	101.7

Finoteselam

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1993	54	71.5	88.1
1994	43.8	65.3	65.3
1995	53	69.7	74.3
1996	40	71.5	86.3
1997	34.7	53.5	70.5
2006	49.7	64.8	69.5
2007	36	52.4	75.6
2008	59.7	69.8	78.1
2009	70	82.3	102.1
2010	58.5	76.5	89
2011	53.4	85.4	114.4
2012	50.6	58	80
2014	54.6	64.4	78.3
2015	46.7	55.7	63.6

Baco

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1974	40	48.6	55.4
1975	52.7	69.3	84.8
1976	62.3	84.6	88.5
1977	39.5	49.6	70.5
1978	60.6	66.4	71.8
1979	70.8	82.6	94.2
1980	49.4	58.5	58.5
1981	41.7	70.1	76.9
1982	21.6	23	23
1983	50	62	62.6
1984	44.5	52	63
1985	65.4	66	66.4
1986	57.5	65.5	104.6
1987	50	51.6	88.9
1988	44	50.4	65.8
1989	45.4	55.5	82.5
1990	50.5	60	74.8
1991	63.4	71.4	92
1992	52.4		
1993	66.8	72.4	79.9
1994	54.1	98.4	111.5
1995	50.2	70.6	80.4
1996	40.7	49.9	56
1997	69	76.3	90.3
1998	79.3	93.1	96.5
1999	80.4	82.4	87.8
2000	48.2	76.9	81.1
2001	66.1	85	121
2002	93	109.2	110.4
2003	60.5	84.8	115
2004	40.2	75.2	107.5
2005	40.5	80.9	109.2
2006	34.5	60.8	76.9
2007	54.9	70.1	81.1
2008	55.5	70.7	83.9
2009	36.7	48.5	58.3
2010	54.6	62.4	64.3
2011	42.2	57.9	71
2013	66.6	82.8	97.1
2014	46	62.5	93.2

Bambase

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1972	45.8		
1973	58.2		
1974	53.4		
1975	70.8		
1976	47.3		
1977	41.3		
1978	62.9		
1979	54.5		
1980	79.3		
1981	57.8		
1982	61		
1983	93.1		
1984	37		
1985	150		
1986	49.8	67.8	73.2
1987	60.2	77.8	102
1988	46.8	88.8	128.4
1989	60.5	79	114
1994	171.1	171.1	177
1995	60.8	60.8	63.2
1996	50.5	77.4	94.2
1997	60.5	88.3	119.1
2005	55	55	68.8
2006	110.4	64.5	74.6
2007	49.7	64.9	74.6
2008	54.5	70.9	96.4
2010	50.6	63.2	88.8
2014	53.4	53.4	78.2

Baro (Yaya-Hurum)

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1988	52.4	95.1	109.3
1989	47.4	64.4	73.7
1990	74.3	88.5	100.8
1991	56	68.9	76.9
1992	56.8	62.5	85.6
1993	61.8	104.3	105.2
1994	70.4	77.8	84.9
1995	42	54.5	62
1996	67.1	67.3	70.7
1997	40.2	55.1	67.1
1998	35.3	65.5	98
1999	45.3	63	92.6
2000	38.1	52.6	74.6
2001	48.6	70.7	81.4
2002	66	79.4	79.4
2003	51.4	71.2	75.5
2004	54.6	76.2	94.5
2006	68.1	89	105.4
2007	45	79.1	91.2
2008	36.4	66.1	79.7
2009	56.7	79.2	94
2012	48.9	79	93
2014	55.1	69.7	93
2015	55.5	79	107

Bedele

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1967	56.1		
1968	53		
1969	47.1		
1970	47		
1971	64		
1972	57		
1973	70		
1975	35.9		
1976	53.3		
1977	46		
1978	36.4		
1979	47.1		
1980	47.8	87	87
1981	45	74	74
1983	45.6	72.9	105.3
1984	50.9	68	102.5
1985	50	79.4	106
1986	51.7	67.7	73.1
1987	62.2	96.7	111.7
1988	64.6	88.9	106.2
1989	58.4	76.5	98.2
1990	53.2	79.9	86.5
1991	46.8	78.4	91
1992	49.5	62	78.5
1993	56	71	102
1994	39	57.9	76.4
1995	50.1	66	92.5
1996	40	68.1	94.1
1997	61	80.3	101.6
1998	60.1	68.9	70.7
1999	104.5	154.7	172.7
2000	63.5	66.2	84.3
2001	63	99.5	119
2002	47.9	58.9	74.3
2003	69	91.8	111.8
2004	57	82	106
2005	55	82.8	110
2006	50	85.5	93.8

....Con Bedele			
2007	83.5	97.5	97.5
2008	63	100	100.5
2009	58.5	86	97.5
2010	75.3	123.3	127.3
2012	60	79.8	98
2013	77.5	78.8	107
2014	51	70.3	80
2015	48.3	66	80.5

Bullen

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1988	76.6	87	108.5
1992	80.2	81.2	85.3
1997	54	73.8	97.2
1998	85.2	101.4	107.9
1999	68.2	72.4	135
2000	72.1	79.3	89
2001	54.8	90.7	94.4
2002	68.8	75.4	77.2
2003	115.7	116.5	132.6
2004	78.8	105.7	113
2005	50.8	71.9	86.9
2006	70.9	79.9	115.1
2007	75.1	94.4	114
2008	79	100.7	110.8
2009	68.5	71.2	71.7
2010	60.8	79.3	95.7
2011	67.1	74.3	110.5
2012	76.5	97.4	106.4
2013	66.4	111.3	113.6
2014	86.9	86.9	112.9
2015	54	79.5	91.1

Chagni

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	42.6	55.8	72.7
1987	48.2		
1988	64	80.4	102.2
1989	75.2	101.4	113.5
1990	69.8	82.3	112.6
1992	99.4	118.8	123.4
1998	72.6	91.3	110.9
1999	56.1	78.2	90.9
2000	56.8	66.4	84.4
2001	59.4	98.8	106
2002	40.4	63.5	71
2003	53	66.2	102.8
2004	89.6	118.6	126
2005	61.2	107.3	140.3
2006	74.4	87	94.1
2007	82.6	97.5	120.3
2008	224.2	228.7	233
2009	47.8	58	76.9
2010	57	66	82.7
2011	59.4	83.4	89.6
2012	56.4	69.3	91.1
2013	62.3	93.8	126.2
2014	87.6		
2015	90.2		

Chewahit

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	36.3	50.9	51.3
1988	46	59.6	82.5
1989	57	64.1	67.7
1990	47.4	62.9	67
1991	63.5	72.3	81.1
1992	72.9	73.2	85.3
1993	50.7	77.8	77.8
1994	54.8	60.1	64.5
1995	48	50.6	65
1996	56.5	63	70.7
1997	48	58.6	78.4
1998	43.8	52.4	58.5
1999	40.9	54.4	54.4
2000	60.4	72.9	82.5
2001	42.7	70.4	88.1
2002	43.1	51.7	64
2003	34.3	50.4	53.5
2004	38.8	62.4	72.6
2005	48.4	71.8	86.2
2006	69.4	97	101.4
2007	45.3	62.3	65.8
2008	36.5	57.2	67.9
2009	39	54.1	61
2010	70	70.5	86.9
2011	40.1	54.2	58.1
2012	99.1	128.8	152.3
2013	92.5	123	143.7
2014	34.9	52.1	61
2015	44	52.3	52.4

Chira

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	52	75.9	81.1
1987	46.7	63.9	89.2
1988	62.5	69.5	85.5
1989	40	72.2	84.6
1990	70	100	101.5
1991	70.3	89.6	120.1
1992	36.1	60.8	66.8
1993	44.5	76.3	86.3
1994	54.3	76.7	88.9
1995	40.1	61.5	63.3
1996	70	78.9	97.1
1997	70.5	83.1	83.1
1998	55	59	84.1
1999	50.8	58.7	61.3
2000	44.5	66.9	74.9
2001	54.5	73	87.5
2002	40	49.3	65
2003	47	65.7	92.8
2004	50.3	84.7	89.8
2005	38	52.2	63.4
2006	45.6	72.5	107.4
2007	40	61.3	66.9
2009	50.2	78.5	88.7
2010	48.6	50.4	66.2
2012	57.6	75.4	83
2013	48	53.3	65.9
2014	44.7	63.4	75.2
2015	45.4	59.1	61.6

Chora

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1988	52.4	65	83
1989	47.4	99.9	122
1990	74.3	77.4	103.1
1991	56	68.1	72.6
1992	56.8	85	98.4
1993	61.8	98.7	113.2
1994	70.4	58.3	67.6
1995	42	59	79.2
1996	67.1	66.5	81.9
1997	40.2	89	108.1
1998	35.3	58.9	76.9
1999	45.3	70.4	78.2
2000	38.1		
2001	48.6		
2002	66		
2003	51.4		
2004	54.6		
2006	68.1		
2007	45		
2008	36.4		
2009	56.7		
2012	48.9		
2014	55.1		
2015	55.5		

Combolcha

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1978	48.9		
1979	56.4		
1980	38		
1981	62.3		
1982	58		
1983	82.8		
1984	49.6		
1985	62.4		
1986	42.8	59.7	80.5
1987	50.5	73.8	99.2
1988	67.9	99.2	109.1
1989	74.8	116.2	129.2
1990	59	60.7	75.2
1991	42.2	45.9	50.4
1992	52.4	61.7	71.9
1993	50.7	65.7	79.8
1994	58.5	78.1	104.1
1995	38.7	53.8	64.2
1996	42.7	79.8	80.3
1997	54.3	64.8	75.6
1998	68.4	86	123.5
1999	61.2	98.2	110.2
2000	50.6	65.2	92.5
2001	71.6	93.1	99.8
2002	64.4	112.6	112.7
2003	60.9	64	71.9
2004	46.8	76.6	93.7
2005	70.4	73.5	90.9
2006	64.8	65	84.3
2007	54.3	70.5	80.5
2008	30.5	50.7	64.5
2009	73.2	79.8	92.8
2010	64.5	96.8	107.4
2011	49.8	68.4	87.6
2012	49.6	71.5	82.6
2013	60.4	74	88
2014	49.6	91.5	100.1

Dangila

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1955	41	49	68
1956	34	50	57
1957	51	87	115
1959	55	75	98
1960	57	91	100
1961	39	51	66
1962	43	61	84
1963	58	81.5	117.4
1964	62	91	119
1965	48.5	76.9	96.9
1966	58.2	75.2	82.9
1967	34	68	75.2
1968	53.5	53.5	68.5
1974	65.1	73.3	87.5
1975	50.3	84.5	112
1976	51.4	95.3	110.9
1987	48	70	81.4
1988	46	60.5	80.6
1989	78.5	95.5	112.6
1990	76.4	107.2	136.8
1992	40	59	71.5
1993	43.2	60.5	84.3
1994	58.8	71.9	98.3
1995	38.2	57.2	66.4
1996	47.2	67.2	87.5
1997	48.5	58.3	70.1
1998	46.7	63.9	80.4
1999	68	85.8	100.5
2000	67	81	108.5
2001	42.5	51.5	79.5
2002	39.5	49.5	65.8
2003	45	78.7	117.7
2004	59	98.8	102.8
2005	59.8	95.3	102
2006	61	88.6	96.1
2007	37	63.5	77
2008	58.5	89.5	120
2009	57.7	74.5	93.8
2010	53.8	67.3	83.6
2011	53.5	73.4	88
2012	53	96.1	109.1
2013	44.3	78.3	116
2014	57.5	86	109.3
2015	47	56.3	64.3

Debark

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1955	53		
1956	60		
1957	50.5		
1963	41		
1984	33.4		
1987	48.6		
1988	72		
1989	123	221.8	235.3
1992	63.1		
1993	24.2	35.7	38.1
1994	36.8	52.5	70.5
1995	27.3	44.1	58.7
1996	124.8	131.5	146
1997	38.9	55.3	63.3
1998	94.6	98.4	98.6
1999	47.9	58.5	61.8
2000	57.2	70.3	117.5
2001	53.8	79.9	90.7
2002	60.7	80.5	96.5
2003	44	58.5	87.5
2004	52.5	56.2	58.3
2005	122.1	142.1	232.3
2006	151	233.2	285.7
2007	87.3	147.6	166.6
2008	84.5	105	112
2009	43.7	64.7	90.2
2010	37	66.5	75
2011	105	115.2	191
2012	48	65	77.7
2013	135.5	191	228
2014	42.5	48	56
2015	42.7	56.7	57.7

Debena

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	35.7	49.5	59.7
1987	56.6	78.2	99.3
1988	56.7	85.9	133.2
1989	102	145.6	162
1990	64.4	98.8	110.2
1991	51.6	75	90.3
1992	64.4	81.9	99.3
1993	46.6	64	89.5
1994	50.9	59.5	67.3
1995	71.8	79.1	89.9
1996	45.1	70	98.1
1997	47.8	75.6	85.8
1998	49.8	67.9	69.3
1999	30.5	58.5	66.5
2000	38.6	56.7	67.9
2001	34.5	55.8	66.3
2002	30.4	46.1	66.7
2003	34.5	54.9	70.9
2004	35.4	60.5	89
2005	35	58.6	86
2006	31.5	58.9	83.4
2007	35	57	86
2008	34	59.5	90.4
2009	33	65.5	96.5
2012	35		
2013	32.8	60.8	85.3
2014	30	57.4	77.5

Debre Berhan

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	46.5	48.8	69.4
1987	34.1	41.3	61.9
1988	46.6	67.1	78.3
1989	30	49	67
1990	53.3	56.3	66.2
1991	45.6	66.9	87.5
1992	58	87.3	97
1993	41.2	69.3	105.7
1994	60.2	75.2	93.8
1995	40	60.3	63.4
1996	41.5	57.2	74.7
1997	31.6	50.3	63.5
1998	40	53.2	77.7
1999	45.7	57.6	71
2000	43.8	74.8	104.9
2001	38.2	62.3	70.3
2002	40.6	54.4	69.8
2003	47.8	63.1	82.8
2004	45.6	64.5	67.9
2005	46.2	61.8	63.3
2006	43.5	70.7	96.3
2007	57.2	69.2	78
2008	57	69.7	83.6
2009	59.5	84.9	92.7
2010	60	87.3	93.8
2011	84.3	109.9	145.2
2012	41	58	85
2013	34.5	43.5	53.3
2014	38.4	60.6	69.2
2015	63.2	66.6	74.6

Debre Elias

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1981	68	77.9	112.2
1982	40.2	71.1	78.6
1983	36	58.8	84.5
1984	51.5	82.6	86.8
1985	47.5	80.1	84.7
1986	37.7	55.9	69.5
1987	35.4	55.8	77.4
1988	49.2	78.2	87.4
1989	45	61	72.8
1990	51	66.1	69.9
1991	45.8	65	81.7
1992	49.2	64.3	82.2
1993	47.2	65	93.1
1994	48.4	71.8	77.6
1995	29.5	57.9	78.7
2003	49	91.6	109.7
2004	38.4	64.7	78.6
2005	30.2	48.3	54.2
2006	36.8	65.2	82.2

Debre Tabor

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1951	53.4	77.1	97.3
1952	53.6	71.4	84.4
1953	51.2	78	103.6
1954	44	75	105
1956	44.5	80	116
1957	75	87	109
1958	58	76	101
1959	47	73	89
1960	52	85	112
1961	67	92	113.5
1968	58	85	101
1969	62	75	86
1974	54.5	72.9	109.5
1975	70.9	90.4	91.3
1976	63.8	72.7	93.3
1977	71.2	82.3	99.2
1978	42.5	75.8	108.4
1979	54	82.3	94.9
1980	45	65.9	93.1
1981	45.8	74.1	96.1
1982	55	74.5	100.8
1983	61	98.8	128.3
1984	62.1	79	84
1985	66	93	99
1986	58	83.3	92.3
1987	42.3	59.5	92.1
1988	50.6		
1989	47	47	73.7
1992	35.5	35.5	55.5
1993	45.1	45.1	61
1994	69.9	69.9	96.3
1995	57.4	57.4	76
1996	44.6	44.6	75.8
1997	104.3	104.3	113.6
1998	67.7	67.7	84.2
1999	55.5	55.5	71.9
2000	47.3	47.3	69.2
2001	62.7	62.7	64.7
2002	81.3	81.3	86.8
2003	80.6	80.6	102
2004	42	42	58.8
2005	69.4	69.4	74

....Con. Debre Tabor			
2006	60	60	81.2
2007	55.5	55.5	65.9
2008	59.5	59.5	77.5
2009	49.4	49.4	51.1
2010	42	42	73
2013	115	115	116
2014	66.2	66.2	84.9
2015	37	39.4	48.5
2011	60.2	60.2	80.8
2012	44.2	44.2	74.7

Dedessa

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	71.3		
1987	97.5		
1988	66.5	65.2	79.1
1989	68	48	61.2
1990	75.5	89.4	109.4
1991	53.7		
1992	80		
1993	40		
1994	57	45.6	52.2
1995	56	101.9	105.4
1996	64.5	57.2	76.8
1997	42.4	69.9	83.2
1998	78	66.2	70.9
1999	64.1	68.6	69.2
2000	116.6	75.1	83.2
2001	55.1	61.1	81.1
2002	60.6	52.1	67.4
2003	103	84.2	107.2
2004	85.9	88.3	90
2005	46.5	90.3	90.3
2006	79.3	59.8	79.2
2007	43	40.8	44.1
2008	99	71.9	106.4
2009	74	91.1	93.6
2010	80	57.2	61
2011	60.2		
2014	83	66.6	74.3
2015	40.5	53.8	64.3

Debre Work

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1970	49	82.7	93
1975	53.1	67.4	80.6
1976	46.7	70.9	93.5
1977	45.8	56.9	78.9
1978	66	111.6	154.2
1979	59.1	78.2	99.7
1980	42.4	49.4	69.9
1981	39.6	64	83.5
1983	47.7	59.8	90.5
1984	42.3	71.2	71.2
1985	46.3	71	95.8
1986	38	58.9	59.6
1987	39.5	44.2	59.5
1988	78.5	89.4	131.8
1989	42.4	50.2	55.6
1990	36.4	47.4	48.5
1992	47.1	49.9	64.9
1993	58.1	60.9	79.2
1994	53.4	61.3	68.5
1995	82.2	84.3	100
1996	51.1	71	71
1997	41	54.2	62.7
1998	52.4	54.4	69.6
1999	29.1	45	56
2000	65.1	93.8	109.2
2001	45	76.4	104.9
2002	45	75	100.8
2003	46.2	73.5	75.3
2004	61.6	84.6	99.1
2005	34	54	64.4
2007	57	57	74.4
2008	36	42.8	56
2009	45	60	82.5
2010	48.5	72	86.3
2011	44	66.5	70.5
2012	37.7	50.7	60.4
2013	53.5	63.5	96.8
2014	46	52	55
2015	39	43	43.2

Dedessa river (Dildy)

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	54.4	78.9	95.9
1987	80	98.5	98.5
1988	57.5	90.7	101.3
1989	88.6	100.5	124.6
1990	60.4	87.2	111.5
1994	60.4	91.4	135.9
1995	65.3	81.7	92.2
1996	73.4	83.4	109.9
1997	56.5	75	80.4
1998	75.3	109.5	134.3
1999	67.4	69.3	80.4
2000	56.8	65.2	109.8
2001	48.5	66.2	72.3
2002	42.3	59.8	66.1
2003	51.1	52.6	55.8
2004	67.4	80	91.6
2005	51.7	61.7	75.9
2006	54.3	59	71.1
2007	48.6	91.1	94.5
2008	40.1	62.8	85.1
2010	80	91.2	104.2
2012	35.6	90.7	97.4
2015	55.1	71.1	88.2

Dejen

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1980	55.8	62.7	80.7
1981	52	82	106.7
1983	63.4	81.7	99
1984	54.5	67.9	81.4
1985	50.3	55.4	60.2
1986	61.7	81.9	100.8
1987	55.3	68.8	69.1
1988	63.6	81	96.5
1989	44.3	72.1	101
1990	48.5	70.7	94.5
1991	41.1	64.6	84.5
1992	57.5	64.2	64.2
1993	44.8	65.2	71.4
1994	65	87.6	103.4
1995	103.4	112.7	125.7
1996	104.6	114.9	129
1997	78.5	87.9	104.1
1998	76.1	115.8	126
1999	89.8	124.6	177.1
2000	64.5	93.3	109.1
2001	72.1	105.2	130.1
2002	64.5	97.9	126.6
2003	56.7	64.8	67.4
2004	37.2	57.5	65.9
2005	44.5	66.5	90.9
2006	58.1	82.3	110.4
2007	43.7	60.5	83.3
2008	69.3	90.1	128.6
2009	40.9	66.9	79
2010	51.1	66	72.1
2011	71.8	82.9	110.3
2012	49.5	50.1	60.2
2013	49.2	62.8	70.4
2014	49.4	79.1	79.1
2015	61.9	50.8	67.4

Deke Istifanos

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1978	62.4		
1979	141		
1981	41.5		
1982	50.3		
1983	50.8		
1984	95		
1985	60.5		
1986	80.4	101	141.8
1987	80	91.3	121.5
1988	70.8	111.2	141.4
1989	70.9	101.5	141.4
1990	60.8	100.7	131.5
1991	80.2	120.3	151.2
1992	70.9	121.1	141.2
1993	80.7	111.1	152
1994	70.5	100.8	111.9
1995	70	90.5	100.7
1996	50.8	71.3	100.7
1997	68	123	123
1998	134	159.7	174.4
1999	66	90.9	119.4
2000	56.5	77.6	118.3
2001	52.5	93.3	125
2002	86	110.5	131.5
2003	80	82.6	98.4
2004	64.5	78.1	112.3
2005	91	138	165.3
2006	67	106	124
2007	112.2	122.2	122.2
2008	235.2	260.2	271.4
2009	51.2	72.2	97.4
2010	45.8	66.9	97
2012	71.4	96.5	111.9
2013	60.5	97.7	100.2
2014	150.9		

Dembecha

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1960	49	70	72
1961	62	87	124
1962	42	69	74
1963	44	72	81
1964	50	76	93
1965	48	60	75
1966	33	56	77
1967	45	55	69
1968	45	60	80
1969	91	106	106
1970	61	121	132
1971	43	62	92
1974	45.1	59	92.7
1975	44.8	74.3	90.5
1976	45	74	74
1977	57	60	60
1978	42	77	105
1986	93.8	119.9	130.7
1987	70	78.2	106.6
1988	58.7	110.1	156.3
1990	57.6	27.7	37.2
1991	46.7	77	79.1
1992	50	66.1	83.5
1993	90.2	65	67.2
1994	66.8	92.7	92.7
1995	48.7	75.2	82.1
1996	71.7	63	81
1997	40	99.7	115.4
1998	60	59.3	74.6
1999	55.5	81.2	95.2
2000	40	71	80.5
2001	55.5	75	100
2002	68.2	66.6	108.8
2003	48	79.2	87.9
2004	48	65.7	86.2
2005	83.5	67	77.5
2006	48.5	69.5	86.9
2007	43	51.2	76.1
2008	52.8	69.5	87
2009	54	66.7	79.1

....Con Dembecha			
2010	59.7	75.6	102.6
2011	43.1	79.2	114.6
2012	41.5	49.4	55.9
2014	52	67	81
2015	44.5	53	63.7

Dengoro

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	161.7	187.7	210.8
1987	114.3	144.3	204
1988	93.3	122.4	148.2
1989	90	98.4	122.6
1990	70	92.5	117.1
1991	88.9	94.6	125.5
1992	73.6	102.2	141.9
1993	60.5	90.9	93.9
1994	165	231.5	267
1995	54	86.5	115.9
1996	92	116.2	131.8
1997	66.3	84.6	115.8
1998	66	82	82
1999	90	94	108.4
2000	119.7	139.9	150.2
2001	48.9	67	83.2
2002	71	84	108.6
2003	68	88	105
2004	71.2	121.2	131.2
2005	88.5	147.8	166.3
2006	74.5	148.5	148.9
2007	55.4	73.8	92.2
2008	81.2	115.1	130.1
2014	70	117	132

Derba

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1974	58.7		
1975	32.1		
1976	38		
1977	48		
1978	41.1		
1979	41.5		
1980	36		
1981	46.6		
1982	60.2		
1983	40.6		
1984	40		
1985	48.5		
1986	46	155.2	212.3
1987	100	98.5	124.5
1988	100	86.3	96.3
1989	96.4	147.6	190.8
1990	46.5	100.6	122.6
1991	75.4	45.1	60.8
1992	45.3	72.6	98.6
1993	49.2		
1994	27.5	90.4	103.4
1995	31.7	89.9	125.4
1996	71.4	106.9	134.6
1997	52.6	101.2	160.5
1998	27	81.5	103.5
1999	26	85.2	103
2000	42	86	129
2001	41.3	109.1	134.9
2002	44	93.3	120.7
2003	36.4	87.6	105.8
2006	77.5	85.7	108.7
2007	45.8	88.5	99.9
2008	40.8	110.4	117.5
2010	50	109.5	116.5
2013	49.8	143.9	212.3
2014	36.9	110.2	121.8

Dimtu

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	47.7	76.6	81
1987	49.5	84.7	107.4
1988	52.5	66.9	76.8
1989	59.9	65.5	80.3
2000	54.4	96.5	120.6
2001	51	100	132.7
2002	46.6	90	101.6
2003	44	82	91
2004	40.8	69.9	98.9
2005	40.8	78.9	83.4
2006	40.5	68.8	61.3
2007	50.6	80.6	91.5
2009	48.6	85.6	92.5
2010	38.8	55.6	65.9
2012	44.8	44.8	47
2013	63	66	79
2014	50.4	75	102.7
2015	50.6	80.6	90.1

Enjabara

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1954	63.2	116.2	123.9
1956	45	65	79
1957	49	91	112
1958	88.7	119.2	146.2
1959	50	93	105
1960	61	67	94
1961	50	87	99
1963	60	69	113
1964	50	86	116
1965	44.2	82.4	105.6
1966	61.4	97.8	124.1
1967	76.4	102.6	113
1968	66.4	79.6	96
1969	53.4	86.6	120
1970	80	100	110.3
1974	43.4	81.7	97.9
1982	48	67.2	96.6
1983	79	101.7	129.8
1984	40	66.5	92.1
1985	58	88.7	113.7
1986	44.8	66.8	86.9
1987	68.6	98.5	124.5
1988	46	86.3	96.3
1989	79.2	147.6	190.8
1990	53.9	100.6	122.6
1991	40.6	45.1	60.8
1992	64	72.6	98.6
1993	72.2	90.4	134.3
1994	55.9	79.2	103.4
1995	62.7	89.9	125.4
1996	65.5	106.9	134.6
1997	87	101.2	160.5
1998	53.6	81.5	103.5
1999	68.7	85.2	103
2000	53.1	86	129
2001	90.4	109.1	134.9
2002	64.1	93.3	120.7
2003	51.4	87.6	105.8
2004	73.6	91.7	132.6

....Con Enjabara			
2005	58.4	81.7	112.3
2006	70.3	85.7	108.7
2007	60	88.5	99.9
2008	79.4	110.4	117.5
2009	98.4	155.2	178.4
2010	59.5	109.5	116.5
2011	89.9	108.6	132.3
2012	62.8		
2013	75.4	143.9	212.3
2014	75.9	110.2	121.8
2015	68.8	89.2	120.3

Enango

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	58.4	97.2	112.5
1987	59	82.6	103.6
1988	40.9	69.6	92.6
1989	49.5	69.9	81.8
1990	65.4	93.5	122.9
1994	49.3	67.7	85.1
1995	81.1	94.3	137
1996	52.8	60.4	83.8
1997	39.8	70.9	74.2
1998	83.2	109.3	113.5
1999	41.3	76.7	95.6
2000	45.7	63	92.3
2001	45.3	61.6	76
2002	68.6	77.7	125.5
2003	100.8	113.6	123.4
2004	52.8	66.3	95.3
2006	69.7	93.8	100
2007	50.4	63.1	81.7
2008	63.6	75.7	96.7
2009	41	73.3	102
2010	48.7	80.5	109.2
2014	69.7	93.5	99.7

Fiche

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1954	43	78.5	120.5
1955	58	111	150
1956	50	96	123
1957	50	92	108
1958	42	84	91
1959	34	66.5	78
1968	65	87.2	118.2
1969	53.8	82.5	109.4
1970	46.3	68.5	93.5
1972	34.3	65.4	86.7
1973	73.2	88.8	102.5
1974	78.9	111.9	137.8
1975	39	69.2	86.5
1976	54.9	68	82.6
1977	89	115.6	132.2
1979	47	77	99.5
1980	69.4	120.9	143.4
1981	64.4	71.8	92.6
1982	60.8	76.8	93.3
1984	45.2	45.2	68.2
1985	42.2	49.6	68
1986	36	55.6	62.2
1987	75	76.2	84.9
1988	47.7	61.1	66.6
1989	35.6	60.4	73.3
1990	51.9	72.3	86.6
1991	41.3	42.7	48.5
1992	39.8	60.7	86
1993	37.6	52.5	73
1994	58.1	63.4	95.1
1995	60	73.3	93.6
1996	82.5		
1997	40.9	61.9	74.3
1998	37	19.4	30.3
1999	56.4	102.8	115.7
2000	51.7	72.8	102.8
2001	44.5	75.9	92.1
2002	90.9	91.3	99.2
2003	44.4	68	75.6
2004	53.8	60.9	68.4
2005	42.8	58.3	73.1
2006	48.7	73.7	94.5
2007	37.6	57.5	70.8
2008	51.1	70.1	93.3
2009	56.4	80	92.6
2010	55.3	83.9	109.1
2011	61.3	78.5	94.4
2012	44.3	61.7	86.1
2013	45.6	66.7	89.3
2014	56.7	93.4	117.7
2015	38.1	67.2	67.7

....Con Fiche

Maligawa

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	80.2	98.8	110.8
1988	70.9	86.1	101.7
1989	56.3	82	100
1990	55.4	55.4	82.4
1991	53.4	60.4	77.2
1992	59.1	78.9	106.1
1993	73.8	87	111.3
1994	50.2	76.3	94.6
1995	37.3	45.6	53.1
1996	50.4	81	124.4
2001	35.2	62.5	80.5
2004	39.1	71.2	80.9
2005	50.7	68.2	79.2
2006	49.6	69.1	69.1
2007	49.2	71.2	80.9
2010	41.7	67.9	67.9
2013	46.3	63.7	89.7

Felege Berhan

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1956	66	79	125.5
1957	41	80	95
1958	53	75	75
1959	37		
1980	40.8	59	77.1
1981	54.2	60.6	71.4
1983	80.3	139.6	148.5
1984	61.6	121.6	126
1985	75.9	124.3	139.3
1986	81.3	135.1	184.1
1987	43.5	49.8	58
1988	43.3	67.6	86.2
1989	68.8	86.2	115.7
1990	65.5	93.6	128.9
1991	66.6	67.3	90.6
1992	110.7	110.7	111.5
1993	45	82	101.6
1994	65.5	75.3	111.5
1995	98.4	108	112.6
1996	51	75	83
1997	83	92	98.1
1998	50	86.6	104
1999	47.2	59.3	83
2000	39.8	59.8	76.3
2001	50.8	65.7	83.4
2002	40.8	63.2	72.6
2003	59.7	79.2	90.2
2004	71.4	77.7	108.1
2005	44	51	72
2006	42	58.4	70.7
2007	42	78.4	114.4
2008	48	73.4	86.8
2009	41	58.6	76.4
2010	75.8	96.7	107
2011	63.5	91.8	102.3
2012	73	82.6	116.6
2013	60.6	80.6	107
2014	76	79.3	95.5
2015	53.4	66.4	74.8

Filiklik

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1978	50.6		
1979	40		
1980	37.4		
1982	45.9		
1983	29.3		
1984	72.4		
1985	31.5		
1986	59.5	68	78.9
1987	35	47.3	49.3
1988	33.5	51.6	80.1
1989	37.5	59.7	77.8
1990	34	44.9	59.3
1991	39	48.3	65.5
1992	53.2	63.4	76.8
1993	52.9	88.6	101.4
1994	42.3	81.2	116.8
1995	29.9	49.2	75
1996	42.7	77.3	104.8
1997	61.2	82.4	101.9
1998	35.6	60.5	71.3
1999	42.3		
2000	45.2	70.8	86.8
2001	36.5	56.7	75.5
2002	29	43.2	49.9
2003	42.3	62.5	78.3
2004	28.8	40.2	54
2005	41	73.6	89.4
2006	41.3	59.2	82.8
2007	26	43.7	64.8
2008	42	54	72
2010	23.5	41.9	58.9
2011	46.4	66.7	82.4
2012	20.6	31	40.3
2013	22.4	38.9	53.9
2014	48.2	63.8	74.1
2015	44.5	55.5	72

Gatira

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	55.8	100.8	116.3
1987	50.8	69.8	80.3
1988	80.5	139.5	165
1989	58.6	96.5	127.9
1990	70	88.3	104.3
1991	58	92.7	107.4
1992	35.5	55	65.3
1993	44.8	54.9	79.4
1994	54	78.4	89.9
1995	59.6	79.6	86.6
1996	47.8	79.7	105
1997	48.7	67.7	72
1998	57.8	92.8	124.1
1999	55.3	89.3	89.3
2000	49.3	55.5	81.2
2001	56.8	70.1	96.4
2002	66.6	78.6	110
2003	55.5	65	75.7
2004	45	61.1	80
2005	68	76.7	104.4
2006	45.2	74.5	90.5
2007	46	68	71.8
2008	39.3	64.6	71
2009	59.6	62.8	82.3
2010	47.8	54	63.5
2012	48.2	56	64.5
2013	59.3	93.9	98.5
2014	46.5	71.9	95.2
2014	42	76.3	95.2
2015	42.3	74.7	97.1

Gembe

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	54.4	60.2	79.1
1988	46.8	63.2	70.1
1989	52.4	95.7	106.4
1990	66.6	71.4	80.6
1991	48.6	89.3	97.7
1992	48.8	87.2	113.6
1993	48.3	88	113.6
1994	48.2	72.6	80.7
1995	61.4	66.6	70.4
1996	69.4	89	101.8
1997	57.4	89.9	103.4
1998	38.8	59.4	69.7
1999	41.7	58.2	70.7
2000	59.4	78.2	89.4
2003	45.2	50.5	75.5
2004	49.0	56.6	79.3
2005	40.2	62	72.2
2006	42.4	69	95.8
2007	43.3	57.9	69
2009	43.1	78.8	83.1
2010	102.3	105.9	127.3
2012	54.7	55.9	67.9
2013	47.5	77.1	93.9

Gondar

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1952	50	63.9	70.7
1953	62.3	78.8	106.3
1954	58.6	64.2	81.1
1955	47.8	76.7	89.9
1956	31	48.5	61.7
1957	47	55.7	70.5
1958	46.5	61.9	79.3
1959	75.8	94.8	105.2
1961	59	86	97
1964	59.2	94.6	114.6
1965	48.2	64.3	74.7
1966	42.1	44.4	61.3
1967	82	86.8	89
1968	45	59.5	68.7
1969	51.9	63.6	87.7
1970	57.1	62.8	82.3
1971	36	41.3	49.6
1972	59.3	80.3	97
1973	53.1	97.5	111
1974	69.5	93.3	111.5
1975	65	87.3	110.1
1976	65.4	73.2	82.2
1977	63.5	80.5	107.8
1978	50.3	55.5	57.2
1979	44	60.6	68.4
1980	54.3	83.5	83.5
1981	30	47.9	55.9
1982	34.3	47.6	58.9
1983	65.4	78.2	91.7
1984	43.9	56.4	73.9
1985	47.8	49.8	73.5
1986	47.1	57.1	71.6
1987	41.3	50.7	59.9
1988	51.3	57.6	63.3
1989	47.9	69.6	75.9
1990	63	78.5	88.1
1991	52.8	63.8	69.9
1992	36.8	51.4	62.3
1993	54.3	57.3	61.6
1994	40.1	53.5	73.3
1995	30.9	51.9	72.7
1996	45.5	55.2	69.4
1997	72.3	92.5	100.9
1998	40.7	51.9	69
1999	48	78.2	81
2000	58.3	60.3	65.1
2001	41	66.7	76.5
2002	60.2	91.7	112.5
2003	69.4	91.3	100.6
2004	51.1	63.3	80.3
2005	45.3	66.4	90.1
2006	70.5	90.6	112.1

….Con Gondar

Jeldu

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	46.6	58.1	68
1988	55	61.3	80
1989	38.7	53.8	60.1
1990	62.8	75.3	83.9
1991	46.3	70.7	99.3
1992	32.2	58.4	77.7
1995	42.9	53.4	96.1
1996	49.4	60.8	79.4
1997	45	46.5	59.8
1998	42.9	52.7	65.1
1999	34.6	51	70.6
2000	33.6	44.9	56.4
2001	46.3	65.3	80.8
2002	42.6	45.1	60.6
2003	35.4	55.6	87.6
2004	27.2	49.5	71.9
2006	52.8	62.2	85.2
2007	39	57.5	60.7
2010	28	52.5	58
2011	29.5	44.1	50.1
2012	51.4	57.1	70.8
2013	37.5	50.3	63.4
2014	45.6	58.7	58.8
2015	31.2	32.2	50.4

Gohatsion

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1972	81.9		
1973	40.6		
1974	52		
1977	57.6		
1978	45.9		
1979	53.2		
1980	44		
1981	57		
1982	48.5		
1983	56.3		
1984	50		
1985	56.2		
1986	60.3	76.4	82.4
1987	45	66.2	76.3
1988	82.3	87.3	94.3
1989	59	86.4	90.6
1990	43.3	52	61.4
1991	42.3	63.4	83.2
1992	37.3	63.3	72.5
1993	84.3	99.5	134.7
1994	47.3	54.5	67.7
1995	42.3	66.6	76.7
1996	47.4	77.2	80.3
1997	60.2	72.5	87.8
1998	85.2	93.5	97.8
1999	57.2	110.5	130.5
2000	51.5	55.7	73.4
2001	45	54	76.7
2002	45	45.3	59.6
2003	53	72	88.4
2004	48.4	61.4	68.7
2005	67.5	80	81.2
2006	54.2	69.5	80.5
2007	48	73.3	80.8
2008	72.5	83.2	132.7
2009	29.5	45.5	57
2010	49.5	48.7	61
2011	62	85.2	119.1
2012	49.2	66.5	83
2013	55.3	106.9	121.2
2014	53.5	72.4	81.3
2015	57.1	71.7	81.2

Gundo Woin

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1979	59.1	79.1	79.7
1980	67.8	97.7	111.3
1981	53.7	68.7	89.9
1982	32.3	46.8	52.3
1983	51.8	81	92.3
1984	32.2	51.7	67.1
1985	83.5	93.5	120
1986	57.2	71.4	88.6
1987	53.7	60.5	70.5
1988	51	74.3	94.6
1989	57.5	94	101.3
1990	84.4	90.6	98.9
1991	79.3	87.2	144.7
1992	51.7	67.7	81.1
1993	68.2	96.8	121.1
1994	66.5	77.3	99.9
1995	91.6	111.4	122.6
1996	63.3	105.6	140.1
1997	47.3	79.2	85.4
1998	62.6	95.9	129.5
1999	57.4	65.3	77.2
2000	58.3	63.5	98.1
2001	37.2	73.4	89.4
2002	38.9	64.6	81.4
2003	72.8	91.2	129.8
2004	62.5	85.7	120.7
2005	46.4	76.1	109.8
2006	73.6	107.9	160.4
2007	133		
2008	48		
2009	74.3		
2010	70.5		
2011	41.2		
2012	33.6		
2013	51.9		
2014	52.9		
2015	34.2		

Gidayana

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	96.9	117.5	144
1987	86.5	102.6	114.4
1988	87.9	92.4	94
1989	48.7	55.5	72.8
1990	76.4	98.6	132.2
1991	37.8	40.6	48.7
1992	40.8	56.8	71.4
1993	71.6	77.2	87.3
1994	72.9	100	128.6
1995	64.5	90.1	103.3
1996	58.7	70.8	78.6
1997	69	113.5	120.2
1998	96.5	127.7	139.7
1999	66.3	88.8	112.3
2000	83.5	88.2	90.7
2001	72.4	84.6	100.4
2002	64.1	70.2	96.2
2003	74	85.3	95.8
2004	65.6	93.8	106.3
2005	91	92.2	105.4
2006	70	82	88.7
2007	88.8	94.4	124.3
2008	67.8	74.3	98.5
2009	64.8	92.3	92.3
2010	63.5	76.5	117.5
2011	59	108.3	130.6
2014	60.2	88.2	109

Gorgora

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1985	31		
1986	28.6		
1987	44.4	46.5	51.9
1988	55.5	105.7	113.5
1989	37.5	54.5	63
1990	35.4		
1992	41.3	53.3	77.2
1993	60.5	79	82.5
1994	50.5	45.3	54.9
1995	65.7	65.7	71.8
1996	65.6	89.4	111.8
1997	40.5	64.2	87.7

….Con Gorgora			
1998	56.2	76.8	96.1
1999	40.9	56.1	69.6
2000	65.8	82.4	87.6
2001	38.6	61.7	83
2002	50.1	54.8	57.8
2003	53.8	76.1	85.1
2004	54.9	72.2	76.8
2005	44.5	71	75.3
2006	54.2	71.2	76.8
2007	55.4	70.6	88.9
2008	40.1	47.2	57.4
2009	44.5	61.7	79.7
2010	46.5	62.9	89.4
2011	39	55.9	76
2012	50	73.5	81.5
2013	49.3	68.6	68.6
2014	36.4	52.5	61
2015	76.2	95.9	101.1

GimijabetMariam

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1959	37	39	47
1988	75.4	96.9	111
1989	44.3	79.3	99.6
1990	66.7	105.1	126.7
1991	66.6	130.5	178.7
1992	68.3	104.1	109.5
1993	55.5	81.49	112.39
1994	64.2	69.7	93.1
1995	41.2	67.8	93
1996	49.8	90.8	124.5
1997	40.6	68.1	79.8
1998	70.7	109.1	113.4
1999	37.6	56.8	72.8
2000	47.2	53.4	74.2
2001	34.6	62.1	81.9
2002	42.8	53.4	67.4
2003	64.6	96.8	111.1
2004	55.8	83.2	107.6
2005	42.6	63.5	75.4
2006	63.7	84.9	105.2
2012	60.6	81.3	110.5
2014	80.5	120	152
2015	120.5	162.8	199.6

Hamusit

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1970	50	70	110
1972	48	85	107
1973	70	100	150.7
1974	60	60	80
1976	60.9	71.3	101.3
1977	70	140	160
1981	84	116	152
1982	75.2	112.4	137.9
1988	90.6	133.1	170.6
1989	69.2	113.3	131.9
1992	106.9	154.4	168.1
1993	81.8	148.6	185.8
1995	106.7	181.6	227.2
1996	54.4	91.5	114.9
1997	99.5	101.2	114.6
1998	124.1	124.1	139.3
1999	49	80	89.7
2000	92	106.5	145
2001	74.9	92.2	113
2002	83.4	124	129.9
2003	68.7	101.6	111.2
2004	71.1	73.2	91
2006	80.6	91.2	110.7
2007	88.8	94.6	123.9
2008	62.8	85.8	112
2009	95	109.7	117
2013	101.1	158.6	175.1
2014	155	193	203

Jimma

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	45.3	56.3	58.6
1987	52.9	70.1	72.8
1988	59.3	94	101.3
1989	41.6	59.3	83.2
1990	36.3	60.4	67.8
1991	57	77.2	85
1992	55.4	65.7	83.2
1993	46.2	52.8	76.8
1994	60.7	86	97
1995	47.8	58	72.2
1996	48.8	66.8	78.6
1997	69	96.3	104.3
1998	62.5	69.5	76.7
1999	49.9	51.4	58.9
2000	50.5	56.3	96.7
2001	56.2	88.5	103.5
2002	42.5	58.8	67.7
2003	42.6	51.8	76.3
2004	46.2	59.3	68.8
2005	60.9	103.1	122.2
2006	44.5	53.2	67
2007	44.6	55.8	75.8
2008	62.3	69.3	82.6
2009	69.7	86.1	126.9
2010	74.6	81.2	122.4
2011	65.7	97.1	115.3
2012	54.9	59.4	78.1
2013	33.4	41.2	54.9
2014	59.1	68.7	100.1
2015	45.4	68.7	81

Kachise (Rs)

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	70.6	85.3	104.6
1987	83.8	89.8	96.6
1988	52	103.3	116.9
1989	47.4	65	72.6
1990	57.4	85.2	101.8
1991	58.2	76.5	90.3
1992	50.1	73.4	84.8
1993	50	87.9	98.8
1994	41.6	62.8	101
1995	49.9	58.1	79.4
1996	54.9	75.5	94.3
1997	55.8	97.7	108.6
1998	61.7	84	92.2
1999	68.4	91.1	103.7
2000	77.7	103.2	113
2001	68.8	90.4	103.6
2002	77.6	103.6	114.3
2003	62.9	78.7	93.6
2004	65.1	103.3	109
2005	100	108.6	117.3
2006	60.2	80.1	92.8
2007	63	73.5	84.9
2008	166.5	186.7	266.3
2009	86.3	86.3	86.9
2010	46.1	49.8	51.3
2011	62	73	86.4
2012	72.2	104.8	116.8
2013	80	118.7	146.7
2014	77.2	87	99.6
2015	81.3	100.7	135.8

Kone

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	76.7	124.5	156.2
1987	58.4	73.9	86.9
1988	60	98.8	142.3
1989	81	89.4	96.5
1990	99.1	99.1	99.1
1991	45.4	89	102.4
1992	63.2	63.2	102.2
1993	70	96.5	108.6
1994	77.2	101.2	113.6
1995	48	71.2	88.2
1996	60	73.1	73.3
1997	60	62	75.6
1998	95.2	149.4	149.4
1999	66.4	121.4	155
2000	65.5	78.5	89.3
2001	59.7	72.8	81.8
2002	46.7	73.8	74.5
2003	57	72.5	87.4
2004	60.5	96.6	111
2005	51.5	61.9	97.4
2006	68.2		
2007	66.9	80.5	95.4
2008	52.3	76.9	109.1
2009	58.4	88.2	104.5
2012	78.8	134.2	182.1
2013	81.9	129	150.4
2015	79.8		

Kelem Meda

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1984	40	60	74.2
1985	60	66	94
1986	60	78.4	97
1987	88.8	124.3	132.8
1988	69	127	149
1989	67.4	120.4	150.4
1990	60.9	60.9	70
1992	42.2	79.8	92.3
1993	67.7	85.2	97.5
1994	53.9	83.9	108
1995	68	78	110.2
1996	52.5	67	83.3
1997	34.2	58.5	81.8
1998	71	95	136
1999	60	76.2	104
2000	53.6	103.6	117.4
2003	62.3	74	80.7
2006	78.2	103.7	144
2009	81.9	103.4	108.2
2010	44.3	73.2	91.8
2011	68.9	118.9	140.4

Mukelemi

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	60.9	70.5	102.4
1988	69.5	95.9	112.4
1989	62.5	80.2	109.6
1990	48.1	74.4	95
1993	48.8	87.5	116.6
1994	62.1	79.4	126.7
1995	115.3	132.4	147.5
1996	65.2	83.2	94.2
1997	55.3	70.6	88
1998	95.9	128.2	129.5

….Cont Mukelemi			
1999	53.5	75.5	85.9
2000	71	85.7	92.7
2001	64.8	72.5	92.6
2002	74.2	79.5	79.6
2003	65.7	87.9	108.1
2004	55.4	86.8	123.9
2005	60	80.3	89.8
2006	80.3	88.4	95
2007	60	81.8	92.8
2008	37.2	47.3	56.4

Meshenti

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1988	49.8	71	78.5
1989	83.2	88.7	92.7
1990	63.4	69.4	81.5
1991	60.3	79	101.9
1992	73.5	88.5	88.5
1993	59.3	67.4	88.4
1994	50.1	63.1	70.7
1995	45.9	52.4	71.2
1996	60.1	105.8	114.8
1997	74	93.2	110.9
1998	57.9	70.8	95.3
1999	79	93.8	99.1
2000	49.4	76.4	85.4
2001	44.8	66.6	92.8
2002	47.6	70.4	74.3
2003	62.9	78.5	90.5
2004	56.7	96.8	107.4
2005	48.9	58.7	77.7
2006	61.9	95.3	124.7

Lemi

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	80.3	83.5	98.6
1987	54	93.1	133.6
1988	85	95.5	115.9
1989	40.4	74.2	110.9
1990	80	117.2	117.2
1992	51.8	53.6	58.9
1993	42.4	65.1	72.9
1994	70	57.7	72.5
1995	75.4	87.2	111.2
1996	96.5	95.8	105
1997	45.8	120.6	150.5
1998	50.1	80.2	120.4
1999	59.2	106.4	143.7
2000	78.4	95.9	121.7
2001	62	90.7	111.1
2002	60.7	81.6	91.8
2003	46.5	73.6	95.9
2004	53.3	73.5	88.5
2005	57.8	79.3	82.9
2006	50	75.2	105.4
2007	74	77.4	104
2008	55	94.2	129.2
2009	41	76	104.4
2010	50.4	98.2	143.7
2012	61.4	98.4	102.4
2013	74.1	100.1	112.6
2014	60.5	106.4	137.3
2015	37.1	61.7	73.2
1994	51.5	61.7	78.9
1995	72.5	89	111.1

Limu Genet

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	66.3	97.2	127.7
1987	60.5	79.3	87.8
1988	45.8	78.7	93.2
1989	55.6	74.3	79
1990	54.7	83.5	85
1991	53	70.1	87.5
1992	51.8	98.5	105
1993	52.7	76	91.6
1994	57.4	72.3	78.3
1995	44.5	44.5	53.7
1996	87.4	91.7	101.5
1997	70.7	76.8	98.1
1998	64.5	79.3	109.9
1999	56.7	74	98.2
2000	73	87.9	104.4
2001	53.2	63.7	87.5
2002	50.0	70.5	76.2
2003	84.5	108.8	122.1
2004	47.7	60.4	74.5
2005	53.7	88.4	107.4
2006	93.7	109.2	150.9
2007	53.5	83.3	98.7
2009	75.2	100.7	123.7
2010	64.0	107	109.4
2012	74.5	79	82.5
2013	79.0	135.7	152.2
2014	72.0	93	109.7
2015	76.7	103.7	119.4

Mehal Meda (RS)

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	42	46.5	76.4
1987	53.2	60	96.4
1988	48.1	51	60.7
1989	42.6	46.9	55.3
1992	51.2	54.6	71.7
1993	32	47.1	61.2
1994	50.1	72.1	89.7
1995	46.4	57.5	73.2
1996	42.5	71.6	81.1
1997	43	52.8	95.8
1998	54.8	73.3	95.3
1999	62.3	80.1	98.7
2000	47	74.2	91
2001	68.5	75.3	108.7
2002	53.2	95.7	100
2003	57	61.5	77
2004	35	54.2	63
2005	31.6	58	60.4
2006	51	63	84
2007	34.8	66	70.6
2008	35.6	48	61.5
2009	34.5	51.2	62
2010	45.3	73.5	89.5
2011	41	80.2	87.6
2012	47.5	74.2	87.6
2013	38.2	43.6	76.3
2014	54.2	62.8	99.5
2015	57.2	89.2	120.3

Merto Lemariam

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	30.9	50.6	62.9
1989	40.3	51.3	64.8
1990	51.7	63.3	63.3
1992	62	122	152
1993	42.5	62.5	91
1994	46.5	63.5	76.6

….Cont Merto Lemariam			
1995	32	45.9	67.5
1996	32.9	35.7	46.4
1997	25.3	46.9	60.9
1998	31.5	46.2	66.3
1999	28.8	38.3	55.7
2000	23.6	38.9	49.4
2001	25.7	39.9	53.1
2002	25.3	42.2	60
2003	37.6	51.9	62.9
2004	46	53.4	63
2005	56.3	57.8	60.8
2006	47.1	74.5	83.1
2014	41.4	51.1	65
2015	50.2	63	70.5

Wetet Abay

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	57.2	85.6	116.6
1988	70.3	65.2	79.1
1989	55.2	48	61.2
1990	78.1	89.4	109.4
1999	154.5	68.6	69.2
2000	73.7	75.1	83.2
2001	58.4	61.1	81.1
2002	37.1	52.1	67.4
2003	54.2	84.2	107.2
2004	33.1	88.3	90
2005	55	90.3	90.3
2006	74.5	59.8	79.2
2007	57	40.8	44.1
2008	69	71.9	106.4
2009	62.5	91.1	93.6
2010	70.5		
2013	55.9		
2014	92.2		
2015	47		

Metema

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1971	72.1	72.2	74.3
1972	80.3	103.6	103.6
1973	56.1	56.1	80
1974	70	78.4	94.4
1975	62.5	90.2	96.9
1976	46.5	64	79.2
1986	121.4	151.9	151.9
1987	67	77	97.6
1988	63	68.2	78.2
1989	52.7	74.9	74.9
1994	35.4	47.5	63.7
1995	40.5	59.5	81.8
1997	80.2	120.7	151.5
1998	49	57.3	67.6
1999	60.1	61.8	80.7
2000	71.2	89.1	112.5
2001	56.7	70.6	74.8
2002	51.1	57.5	60.7
2003	60.9	93.4	104.9
2004	51.3	51.3	60.2
2005	50	57	74.6
2006	65.4	71.2	98.2
2007	59.4	79.2	95.1
2008	69.1	76.8	88.4
2009	50.9	55.9	60
2010	65.8	76.2	121.8
2011	38	73	74.3
2012	96	119	132
2013	64	71.7	76.2
2014	64	72	111.1

Motta

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1985	46.2		
1986	46.9		
1988	38	89.3	107.2
1989	32.3	70.5	85.2
1990	56.8	67.4	74.9
1991	42.9	55.5	66.8
1992	53	59.8	68.8
1993	44.7	64.5	76.7
1994	47.1	60.6	100
1995	46.4	65.1	82
1996	67.9	110.9	133.6
1997	34.3	51	69.1
1998	48	57.9	68.1
1999	36.5	53.2	59.5
2000	47.1	65.3	65.3
2001	68.4	95.1	124.4
2002	43.7	55.7	66.9
2003	62.8	98.2	116.2
2004	51.3	62.3	92.2
2005	46.7	55.7	64.7
2006	40.4	54.8	76.3
2007	57.4	63.2	63.5
2008	40.5	67.1	82.7
2009	33.5	53.4	68.3
2010	77.5	96.1	140.7
2011	72.1	116.5	125.8
2012	62	67.6	87.7
2013	69.1	77.7	100
2014	48.2	68	93.6
2015	48	70.4	80.2

Nekemte

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1953	40		
1954	33		
1971	66		
1972	75		
1973	67.9		
1974	91.6		
1975	58		
1976	117		
1977	70		
1978	56.2		
1979	51.5		
1980	75	89.3	138.8
1981	123.5	133.1	165.2
1982	62.1	70.4	113
1983	54.2	83.2	92.4
1984	66.6	77.2	77.2
1985	94.5	110.7	130.1
1986	63.9	100.9	108.5
1987	81	89.7	106
1988	50.3	76	93
1989	57	92.4	96.8
1990	60	97	101.2
1991	55.9	108.1	115.8
1992	63.9	102.7	130.6
1993	80	110.8	141.3
1994	78.4	93.4	119.1
1995	67.3	102.6	144
1996	105.4	165.4	178.9
1997	72.3	105.2	138.8
1998	126.5	139.5	155.4
1999	71.2	81.7	103.2
2000	84.2	101.5	125.3
2001	70	96.7	117.9
2002	67.7	87	108.5
2003	53.3	84	115.8
2004	91.8	129.5	132.4
2005	85.4	134.7	153.9

….Cont Nekemte			
2006	56.9	80.6	121.1
2007	89	122	132.5
2008	71.6	89.7	106.3
2009	58.3	80.3	98.7
2010	137.5	160.7	182.9
2011	74	100.1	114.3
2012	105.5	149.4	158
2013	59.2	85.1	96.5
2014	110.6	116.2	199

Muletadiga

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1989	64.9	91.2	101.2
1990	60	72.7	78.9
1991	52.2	75	87.9
1992	40	62.8	86.7
1993	48.2	66.3	76.7
1994	52.1	67.7	105.5
1995	46.3	62.1	83.8
1996	61.1	70.1	79.6
1997	38.9	61.8	83.5
1998	116.7	129.4	144.3
1999	73.3	84.2	96.8
2000	60.1	95.9	113
2001	47.6	72.5	72.5
2002	38.3	50.6	67.3
2003	51.1	83.1	86.6
2004	50.1	64.2	81.1
2005	53.8	92.7	127.9
2006	48.6	71.2	92.4
2007	52.7	71.7	76.7
2008	118.6	153.1	165.9
2009	41.2	67.2	70.2
2010	53.5	79.6	101.1
2011	53.3	80	89.5
2014	65	87	107

Neshi

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	40.2	50.4	65.4
1987	74.4	50.4	65.4
1988	85	82	82
1989	53.1	77.6	80.4
1990	63	77	102
1991	56.2	80.1	90.3
1992	60	92	121.4
1993	70.4	135	153.7
1994	58	85.6	97.6
1995	68.8	99	131
1996	65.0	103.6	103.6
1997	62	104.2	126.6
1998	72	114	146
1999	78.2	132.2	188.6
2000	63.6	114.2	157.9
2001	65.2	87.2	100.6
2002	60.8	80.6	95.5
2003	70	135.2	175.2
2004	67	120	135
2005	60.6	69.5	78.5
2006	67.1	120	165
2007	69	125	147.2
2008	49	79	95
2009	40	65.5	97.5
2010	60.5	102.8	133.1
2011	39	74.3	84.3
2013	60.4	113.1	143.6
2014	77	94	105.4
2015	73	99.4	147.2

Nolekaba

Year	Rainfall depth having a duration		
	1-day	2-days	3-days
1992	54.6	64	85.5
1993	55	67	103.5
1994	86	122	132
1995	49.6	78	98.5
1996	52	77	109.4
1997	56	92	112.6
1998	58	74	86.2
1999	56.1	80.7	99.9
2000	49.1	73.6	106.6

….Cont Nolekaba			
2001	65.2	85.8	97.8
2002	94.6	121.4	134
2003	40.2	68.3	92.1
2004	85.2	85.2	155.2
2005	79.1	89.3	97.7
2006	57	71.9	87.5
2007	73	96.5	119.7
2008	76	83.7	101.9
2010	59	64	89
2014	72.5	112	119

Pawe

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	79.8	89.8	95.6
1988	105.8	120.2	179
1989	115.8	135.2	156.8
1990	65.2	76	91.2
1992	86.7	113	114.8
1993	58.2	81.1	116.5
1994	94.4	96.1	132.5
1995	108.2	119	134.2
1996	90.8	106.7	144.9
1997	150.1	198.2	201.9
1998	87.7	104.8	174.1
1999	53.8	71.8	87.6
2000	72.4	72.7	98
2001	72.2	109.7	140.8
2002	62.6	70.1	107.7
2003	88.7	100.7	104.5
2004	71.8	74	128.6
2005	70	86.5	88
2006	66.2	98.8	129.7
2007	56.6	94.8	123.6
2008	81.2	120.1	126.1
2009	88.4	98.8	107
2010	85	111.4	133.4
2011	48.6	60.9	73.9
2012	69	129.4	151.2
2013	111	137	173.8
2014	61.5	319	319
2015	64.7	126.9	128.2

Shambu

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1957	23.2		
1958	44		
1959	39.1		
1961	31		
1980	40	85.8	137
1981	33.4	76.3	111.7
1982	39.2	53.9	67.2
1984	45.6	76.1	92.5
1985	55.5	118	118
1986	50.2	54.2	77.2
1987	54.5	79.3	84.7
1988	58.1	74.4	87.6
1989	51.3	73.6	107.7
1990	91.3	134.7	145.3
1991	50.2	64.2	86.6
1992	85.1	92.2	96.1
1993	51.6	91.8	101.1
1994	57.8	80.6	85.4
1995	45.7	63.7	70.9
1996	66.2	94.8	133.6
1997	58.7	90.9	101.4
1998	70	74	87.4
1999	55.1	80.7	95.5
2000	45	57.5	67.4
2001	38.7	56.5	78.8
2002	70.3	103.2	140.2
2003	53.2	68.4	87.6
2004	51.4	75.3	78.5
2005	49	61.5	73.1
2006	48.7	64	70.8
2007	38.5	54.5	69.2
2008	48.8	75.2	95.1
2009	73.6	78.8	94.8
2010	45	81	90.8
2011	57.6	78.3	79.7
2012	54.2	77.8	90.4
2013	44.3	68.8	79.4
2014	56	64	68.7
2015	40.7	63.8	82.9

Sibusire

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	58.3		
1987	53.8		
1988	58.4	65.2	79.1
1989	60.3	48	61.2
1990	46.2	89.4	109.4
1992	62.3	88	124.6
1993	52.6	73.6	90.7
1994	49.3	45.6	52.2
1995	76.3	101.9	105.4
1996	43.3	57.2	76.8
1997	47.7	69.9	83.2
1998	61.9	66.2	70.9
1999	55.7	68.6	69.2
2000	37.6	75.1	83.2
2001	38.9	61.1	81.1
2002	40.2	52.1	67.4
2003	55	84.2	107.2
2004	34.2	88.3	90
2005	48.2	90.3	90.3
2006	60.1	59.8	79.2
2007	58.4	40.8	44.1
2008	50.9	71.9	106.4
2009	64.3	91.1	93.6
2010	49.7	61.1	76
2011	47.1	57.2	61
2012	42.3		
2013	78.1		
2014	38.7	66.6	74.3
2015	62	53.8	64.3

Tillili

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1974	56.4	109.7	109.7
1976	51	79.9	87
1980	58.1	69.4	93.8
1981	62	90.1	113
1982	76.6	94.2	101.3
1983	62.9	86.1	99.9
1984	51.7	78	96
1985	69.4	89.3	118.4
1986	64	80	100.2
1987	46.6	62.9	95.3
1988	53.1	69.4	104.9
1989	66.4	95.9	133.1
1990	97.2	159.5	187.2
1991	49.3	97.9	129.2
1996	36.3	59.1	81.5
1997	63.5	99.7	121.1
1998	53.3	82.4	105.8
1999	47.5	80	102.4
2000	66.5	90.1	112.2
2001	50	88.5	102
2002	45.7	70.6	95.1
2003	46.8	77.5	95.3
2004	68	94.4	116.1
2005	69.3	90.8	106.8
2006	58.5	75.9	93.1

Tis_Abay

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1982	74.5	84.5	91
1983	68	84.8	110.5
1984	40	60	70.1
1985	40.3	56.6	72.5
1986	68.8	95.9	108.2
1987	52.3	63.3	87.3
1988	60.2	85.5	102
1989	60.4	111.3	144.3
1990	63.5	113.9	123.9
1991	98	116	150.8
1992	50.7	66	96
1995	34.5	57.9	72.5
1996	37.4	62.2	86.8
1997		79.5	95.8
1998	56		
1999	46	85.7	97.7
2000	83	105.1	107.5
2001	64.3	77.6	87.6
2002	63.2	71.2	83.4
2003	40.6	68.1	88.1
2004	66.6	90.8	103
2005	73.3	100.4	149.4
2006	93.8		
2007	40.5	57.8	74.1
2008	56.9	70.5	80.4
2009	55.5	57.2	86.2
2010	61.5	72.8	84.8
2011	65.8		
2012	47.1	74.2	90.6
2013	49.2	66.5	68.8
2014	78.4	86.5	86.5
2015	32.5	58.5	71.1

Wegel Tena

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1980	37.2	54.8	70
1981	37.2	55	64.2
1982	44.2	55.5	70.7
1983	32.6	59.2	69.7
1984	28.3	30.8	31.3
1985	33.2	42.1	58.9
1986	50.2	74.8	95.3
1987	48.5	63.1	66.2
1988	61.8	85.6	113.1
1989	20.2	36	46.2
1992	52	71.4	89
1993	46.6	63.1	89.4
1994	32	50	57.3
1995	97.2	102.4	107.1
1996	49.5	66.5	80.9
1997	34.5	58.2	68.8
1998	53.2	89.2	107
1999	43.7	78.9	81.3
2000	36.6	61.6	69.1
2001	44.2	57.4	80.4
2002	49.8	96.8	106.6
2003	54	60	88.4
2004	44.6	80.2	97.5
2005	48.2	62.3	92.6
2007	40.8	58.8	75.1
2008	35	57.2	70.7
2009	40.6	40.7	47.8
2010	44	83.3	91.7
2011	56.6	74.6	78.8
2013	38	58	74.7
2014	47	79	87.4

Yanfa

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	70.5		
1988	75.8	65.2	79.1
1989	65	48	61.2
1990	88.4	89.4	109.4
1991	53.4	72	107.5
1992	67.2	88	124.6
1993	73.2	73.6	90.7
1994	68.3	45.6	52.2

….Cont Yanfa			
1995	81.5	101.9	105.4
1996	90.8	57.2	76.8
1997	94.3	69.9	83.2
1998	49.7	66.2	70.9
1999	58.1	68.6	69.2
2001	104.5	61.1	81.1
2002	50.9	52.1	67.4
2003	46.4	84.2	107.2
2004	54.9	88.3	90
2005	63.7	90.3	90.3
2006	61.5	55	72.3
2007	52.2	40.8	44.1
2008	43.9	71.9	106.4
2009	48.3	91.1	93.6
2012	51		

Werejiru

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1987	76.8	87.8	133.5
1988	71.2	84.5	112.7
1989	71.2	100.4	121
1990	62	90.5	115.7
1993	58.9	99.3	104.9
1994	53.2	69.1	85.3
1995	62.4	70.2	94
1996	72.6	99.3	100
1997	76	90.2	117.4
1998	68.6	98.5	98.5
1999	61.5	71	79.2
2000	70.9	97.1	97.1
2001	79	101.9	106.4
2002	53	88.8	102.1
2003	73	85	99.7
2004	70.5	96.3	109
2005	73.8	77.1	93.6
2006	57.3	84.1	84.1
2007	73.2	90.1	96.2
2008	94.5	96.6	142
2010	61.7	36.2	36.2
2011	61.5	93.6	115.9
2012	73.4	67.1	67.1
2014	50.7	75.7	101.8

Yetemen

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1975	47.5	57.5	65
1976	43.6	55.6	72.7
1977	53.6	66.1	94.1
1980	38.8	62.3	91.1
1981	54.5	60.7	69.9
1982	36.1	42	58.8
1983	37.5	55.2	81.5
1984	70.8	88.2	121.1
1986	40	49.1	84.6
1987	67.6	67.6	87.8
1988	48	88	94.7
1989	80.5	136	196.5
1990	41.2	70.3	81.1
1991	47	57	64.5
1992	58	80.7	98.3
1993	89.2	95.4	105.9
1994	90.6	151	153
1995	30.9	47.2	72.6
1996	60.1	60.1	71.6
1997	47.2	60.6	69.2
1998	39	68.5	80.9
1999	44	59.9	78.3
2000	59.4	59.4	69.2
2001	34	56	65.5
2002	39.2	74.9	103.2
2003	30.2	55.7	74.3
2004	54.3	64.6	77.3
2005	32.3	54.8	64.3
2006	38.5	70.5	103.6
2007	33.5	55.5	75.7
2008	86.3	116.7	137.2
2009	25.5	45.5	64.5
2010	126.5	147.1	171.6
2011	99.5	123	150.5
2012	30.5	54	76.5
2013	35.2	65.2	93.5
2014	31.5	59.4	71.9

Wereta (Add)

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1986	46.4		
1987	50		
1988	108.2		
1989	114.8		
1990	70.2		
1991	64.6		
1992	65.8		
1993	62.4		
1994	68		
1995	48		
1996	72.4		
1997	35.9		
1998	55		
1999	64.5		
2000	51		
2001	73.5		
2002	100.6		
2003	108		
2004	100.2	85.7	101.2
2005	79	137.1	163.1
2006	73.7	117.8	136.3
2007	63.5	82	94.5
2008	97	88.8	98.7
2009	118.6	90.2	102.4
2010	70	82	97.4
2011	66	79.4	91.5
2012	57.5	128.7	161.3
2013	80	98.6	110.4
2014	60	87	99.4
2015	100.5	83.6	99.6

Yetnora

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1988	60.8	80.5	109.3
1989	48.7	72.6	87.8
1990	64.3	90.4	110.8
1991	42.2	45.1	63.8
1992	43	47.4	63.3
1993	52.3	52.3	74.3
1994	54.1	82	113.4
1995	51	62	69.5
1996	42.7	67.2	84.7
1997	47.3	59.5	70.1
1998	60.7	76.7	80.7
1999	68.7	77.5	90.4
2000	52.1	74.3	74.3
2001	44.9	79.4	100.6
2002	64.4	128.5	139.2
2003	35.7	56.1	58.3
2004	46.8	73.9	100.4
2005	37.3	56.9	61
2006	46	70	91.2
2007	35.3	49.7	60.8
2008	38.1	51.1	61.4
2009	37.1	58.3	63.4
2010	49.2	55.8	64.1
2011	57	64.2	70.2
2012	34.2	59	70.5
2013	39.7	52.2	74.5
2014	37.1	37.8	56
2015	48.4	54.2	89.5

Zege

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1975	70.5	81.7	92.6
1976	69.6	88.4	109.1
1977	63.8	81.1	135.5
1978	48.2	76.4	88.1
1979	61.8	86.6	96.6
1980	63.1	92	107.3
1981	71.5	104.5	134.4
1983	46.6	86.2	112.7
1984	61.1	88.8	124.5
1985	51.3	100.8	119.5
1986	37	60.6	89.5
1987	40.7	59.2	79.3
1988	37.1	61.6	79.7
1989	37.2	65.6	89.8
1990	34.1	57.5	64.3
1995	49.6	123.9	137.1
1996	71.8	72	90.4
1997	76.2	82.2	108.8
1998	65.5	89.9	100.9
1999	38.3	71.4	100.8
2000	58.7	77.2	105
2001	37.5	57.4	73.7
2002	41.5	74	110.3
2003	39.8	67.4	94.7
2004	37.5	63	87.2
2005	42.7		
2006	97.3	77.9	112.2
2007	97.5	105.7	134.2
2008	54.9	102.5	128.9
2009	49.5	88.5	126
2010	52.6	81	111.7
2011	123	123.9	137.1
2012	37.4		
2013	47.8	84.1	112.5
2014	37.4		
2015	39		

Merawi

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
1982	51.2	66.8	83.3
1983	71	94.6	112.6
1984	98	122.9	208.8
1985	56.6	71.6	94.3
1986	65.7	94.3	117.3
1987	49	67.4	92.4
1988	53.5	94.3	98.1
1989	50.3	64.5	77.9
1990	83.6	158.1	171.5
1991	93.1	128.9	128.9
1992	73	87.3	97.5
1994	51.5	61.7	78.9
1995	72.5	89	111.1
2005	72.8		
2006	80.8		
2007	50.7		
2008	64.9		
2009	94.1		
2010	68.9		
2011	77.1		
2012	95.4		
2013	52.1		
2014	54.4		
2015	48.2		

Shola Gebeya

Year	Rainfall depth having a duration of		
	1-day	2-days	3-days
2006	28.1	52.1	76.9
2007	39.9	52.4	77.3
2008	35.9	63.7	80
2009	47.5	52	78.9
2010	30.3	42.6	51.4
2011	32.5	58.1	82.4
2012	45.6	48.3	77.2
2013	45.2	55.7	70.2
2014	36.4	45.5	71.2
2015	37.2	58.5	60

Rainfall depth having a duration of 1- day											
Feres Bet		Nefas Mewcha		Gondar A.P.		Haike		Ambo Met		Abasina Joger	
Year	1-day	Year	1-day	Year	1-day	Year	1-day	Year	1-day	Year	1-day
1980	64.6	1964	45.0	1986	37	1966	49.7	1966	31	1986	92.7
1981	80	1971	47.7	1987	41.3	1967	59.8	1967	32	1987	58.2
1982	48	1972	47.3	1988	51.3	1968	49.4	1968	42.7	1988	60.7
1983	52.8	1973	43.6	1989	47.9	1969	53.6	1969	58	1989	70.2
1986	45.2	1974	45.9	1990	63	1970	50.4	1970	29	1990	66.8
1987	88.4	1975	46.3	1991	52.8	1971	50.6	1971	37	1991	60.6
1988	36.5	1976	45.3	1992	36.8	1972	55.0	1972	35	1992	73.2
1989	32.6	1978	45.8	1994	40.1	1973	46.7	1973	45	1993	95.0
1990	32.2	1979	46.3	1995	30.9	1974	48.6	1974	29	1994	40.0
1991	25.7	1980	45.8	1996	45.5	1975	49.5	1975	26	1995	97.1
1992	24.8	1981	44.8	1997	72.3	1976	53.1	1976	26	1996	73.5
1994	49.5	1982	49.8	1998	64.6	1977	54.1	1977	18	1997	74.3
1996	75.6	1983	46.1	1999	58.1	1978	50.6	1978	37.1	1998	69.4
1997	105.2	1984	49.0	2000	92.6	1979	53.2	1979	28.5	1999	89.7
1998	71.5	1985	47.3	2001	65.1	1980	42.5	1980	38.5	2000	61
1999	55.2	1986	47.6	2002	60.2	1981	48.6	1981	26.7	2001	78.8
2000	87.5	1987	54.3	2003	69.4	1982	48.9	1982	22.3	2002	77.8
2001	77.5	1988	49.2	2004	51.1	1983	52.2	1983	25	2003	92.1
2002	57	1989	37.5	2005	45.3	1984	53.8	1989	37.8	2004	57.7
2003	44.1	1990	45.8	2006	70.5	1985	71.3	1990	52.8	2005	86.9
2004	52.7	1991	49.8	2007	48.1	1986	32.0	1991	30.1	2006	66.8
2005	64.5	1992	44.2	2008	51.2	1988	59.6	1992	44.3	2007	45
2006	84.9	1993	44.9	2009	46	1989	47.5	1993	38.8	2010	40
2007	52.2	1994	46.6	2010	52	1990	63.5	1994	50.3	2014	63.5
2008	58.2	1996	46.8	2011	88.1	2003	48.8	1995	27.2		
2009	51.2	1997	46.1	2012	52.8	2004	49.0	1996	64		
2010	69.3	1998	48.5	2013	41.3	2005	51.9	1997	30.5		
2011	79.4	1999	47.7	2014	44.3	2006	51.4	1998	60.6		
2012	73.8	2000	43.9	2015	54	2007	52.1				
2013	83.1	2001	59.7								
2014	96.5	2005	45.7								
2015	101.2	2006	48.7								

Rainfall depth having a duration of 1- day											
Mendi		Sirinka		Yejubie		Amba mariam		Gebre Guracha		Mekane Selam	
Year	1-day	Year	1-day	Year	1-day	Year	1-day	Year	1-day	Year	1-day
1986	67.8	1987	57.7	1988	91.6	1989	26.0	1980	37.4	1988	33.0
1987	57.4	1988	78.3	1989	38.3	1994	43.0	1981	37.1	1989	30.2
1988	72.3	1989	48.1	1990	39.6	1995	54.1	1986	36.9	1999	24.6
1989	94.5	1991	36.9	1991	31.1	1996	27.4	1987	37.4	2000	32.2
1990	58.5	1992	50.9	1996	36	1999	50.4	1988	40.6	2001	39.1
1991	40	1993	74.1	1997	43	2000	41.0	1989	39.4	2002	24.8
1992	41.5	1994	48.5	1998	58	2001	60.5	1990	39.4	2003	32.6
1993	80.8	1995	62.5	1999	30.2	2002	38.3	1991	39.3	2004	28.3
1994	71.5	1996	88.9	2000	34	2003	44.0	1992	40.1	2005	32.5
1997	78	1997	57.2	2001	53.5	2004	27.6	1993	37.3	2007	26.3
1998	162.5	1998	73.3	2002	35.1	2005	49.6	1994	29.0		
1999	95.8	1999	46.6	2003	33.6	2006	34.9	1995	35.4		
2000	94.8	2000	46.2	2004	48.2	2007	50.9	1996	37.2		
2001	72.5	2001	32.1	2005	46.9			1999	29.8		
2002	75.9	2002	41.6	2006	54.2						
2003	70.5	2003	36.0								
2004	77.6	2004	51.4								
2006	176.5	2007	52.4								
2007	63										
2008	56.1										
2010	51.6										
2014	55.8										

Table B.2 Approximate longitude & latitude for the available stations in UBNB from the grid longitude & latitude of the reanalysis data

Station			For ECMWS 0.5 by 0.5 Degree Grid Size			For GLADS 0.25 by 0.25 Degree Grid Size		
No.	longitude	latitude	Approximated longitude	Approximated latitude	Indicated Grid No.	Approximated longitude	Approximated latitude	Indicated Grid No.
1	36.000	9.033	36.0	9.0	9	36.125	9.125	14
2	38.157	10.113	38.0	10.0	39	38.125	9.375	71
3	36.233	8.367	36.0	8.5	10	36.125	8.375	15
4	37.493	11.275	37.5	11.5	31	37.375	11.375	53
5	36.600	7.850	36.5	8.0	18	36.625	7.875	31
6	39.033	10.033	39.0	10.0	50	38.875	10.625	83
7	37.074	9.886	37.0	10.0	24	37.125	9.875	45
8	38.467	11.750	38.5	11.5	42	38.375	11.625	74
9	37.600	12.767	37.5	12.5	29	37.625	12.875	58
10	37.840	8.985	38.0	9.0	41	37.875	9.625	65
11	37.850	8.983	38.0	9.0	41	37.875	9.625	65
12	36.333	9.267	36.5	9.5	15	36.375	9.375	21
13	36.750	9.050	37.0	9.0	26	36.625	9.125	27
14	36.500	8.750	36.5	9.0	16	36.375	8.625	24
15	34.520	10.070	34.5	10.0	1	34.625	10.125	1
16	36.983	8.300	37.0	8.5	27	37.125	7.875	48
17	36.793	10.661	37.0	10.5	23	36.875	10.625	34
18	37.059	12.540	37.0	12.5	19	37.125	12.625	41
19	37.083	9.117	37.0	9.0	26	37.125	9.125	47
20	37.322	11.603	37.5	11.5	31	37.375	11.625	52
21	37.385	11.595	37.5	11.5	31	37.375	11.625	52
22	34.733	9.750	34.5	10.0	1	34.625	9.875	2
23	36.900	7.967	37.0	8.0	28	36.875	7.875	39
24	36.333	8.450	36.5	8.5	17	36.375	8.375	25
25	36.082	10.596	36.0	10.5	7	36.125	10.625	12
26	36.499	10.974	36.5	11.0	13	36.375	10.875	20
27	37.228	12.335	37.0	12.5	19	37.125	12.375	42
28	36.233	7.733	36.0	8.0	11	36.125	7.875	16
29	36.117	8.350	36.0	8.5	10	36.125	8.375	15
30	39.718	11.084	39.5	11.0	52	39.625	11.125	92
31	36.846	11.434	37.0	11.5	21	36.875	11.375	32
32	37.898	13.142	38.0	12.0	36	37.875	11.875	63
33	36.283	8.400	36.5	8.5	17	36.375	8.375	25
34	39.500	9.633	39.5	9.5	54	39.375	9.625	88
35	37.470	10.300	37.5	10.5	33	37.375	10.375	55

……Cont.								
36	37.739	10.326	37.5	10.5	33	37.625	10.375	62
37	37.995	11.867	38.0	12.0	36	38.375	11.875	73
38	38.162	10.651	38.0	10.5	38	38.125	10.625	68
39	36.100	9.383	36.0	9.5	8	36.125	9.375	13
40	36.400	8.683	36.5	8.5	17	36.375	8.625	24
41	38.151	10.171	38.0	10.0	39	38.125	10.125	70
42	37.226	11.873	37.0	12.0	20	37.125	11.375	43
43	37.486	10.566	37.5	10.5	33	37.375	10.625	54
44	35.733	9.200	35.5	9.0	5	35.625	9.125	8
45	38.651	9.426	38.5	9.5	46	38.625	9.375	81
46	37.233	7.850	37.0	8.0	28	37.125	7.875	48
47	35.683	9.167	35.5	9.0	5	35.625	9.125	8
48	36.919	10.995	37.0	11.0	22	36.875	10.875	33
49	38.067	10.743	38.0	10.5	38	38.125	10.625	68
50	37.609	10.850	37.5	11.0	32	37.625	10.875	61
51	38.733	9.767	38.5	10.0	45	38.625	9.875	80
52	38.243	10.053	38.0	10.0	39	38.125	9.375	71
53	37.050	10.717	37.0	10.5	23	37.125	10.625	44
54	36.200	7.983	36.0	8.0	11	36.125	7.875	16
55	38.400	9.800	38.5	10.0	45	38.375	9.875	76
56	36.667	7.833	36.5	8.0	18	36.625	7.875	31
57	36.617	9.867	36.5	10.0	14	36.625	9.875	26
58	35.833	9.167	36.0	9.0	9	35.875	9.125	10
59	38.240	10.004	38.0	10.0	39	38.125	9.375	71
60	37.420	12.550	37.5	12.5	29	37.375	12.625	50
61	37.432	12.521	37.5	12.5	29	37.375	12.625	50
62	37.300	12.250	37.5	12.5	29	37.375	12.375	51
63	38.089	10.929	38.0	11.0	37	38.125	10.875	67
64	39.667	11.300	39.5	11.5	51	39.625	11.375	91
65	37.380	11.770	37.5	12.0	30	37.375	11.625	52
66	38.083	9.250	38.0	9.5	40	38.125	9.125	72
67	36.817	7.667	37.0	8.0	28	36.875	7.625	40
68	37.860	9.583	38.0	9.5	40	37.875	9.625	65
69	39.517	11.183	39.5	11.0	52	39.625	11.125	92
70	36.783	8.683	37.0	8.5	27	36.625	8.625	29
71	38.900	9.817	39.0	10.0	50	38.875	9.875	84
72	36.950	8.067	37.0	8.0	28	36.875	8.125	38
73	36.917	8.100	37.0	8.0	28	36.875	8.125	38
74	39.660	10.315	39.5	10.5	53	39.625	10.375	93
75	38.750	10.750	39.0	11.5	49	38.625	10.625	79

……Cont.								
76	35.100	9.783	35.0	10.0	3	35.125	9.875	4
77	37.164	11.411	37.0	11.5	21	37.125	11.375	43
78	38.280	10.880	38.5	11.0	43	38.375	10.875	75
79	37.284	11.473	37.5	11.5	31	37.375	11.375	53
80	36.414	12.775	36.5	11.5	12	36.375	12.875	18
81	37.890	11.074	38.0	11.0	37	37.875	11.125	64
82	35.533	9.333	35.5	9.5	4	35.625	9.375	7
83	36.483	8.950	36.5	9.0	16	36.375	8.875	23
84	38.467	11.734	38.5	11.5	42	38.375	11.625	74
85	36.463	9.083	36.5	9.0	16	36.375	9.125	22
86	37.268	9.723	37.5	9.5	34	37.375	9.625	56
87	35.833	8.950	36.0	9.0	9	35.875	8.875	11
88	36.410	11.312	36.5	11.5	12	36.375	11.375	19
89	36.967	7.700	37.0	8.0	28	37.125	7.625	49
90	37.121	9.571	37.0	9.5	25	37.125	9.625	46
91	39.550	9.218	39.5	9.0	55	39.625	9.125	95
92	36.872	9.040	37.0	9.0	26	36.875	9.125	35
93	39.600	11.750	39.5	11.5	51	39.625	11.625	90
94	37.021	10.251	37.0	10.5	23	37.125	10.625	44
95	37.579	11.488	37.5	11.5	31	37.625	11.375	60
96	39.221	11.590	39.0	11.5	49	39.125	11.625	86
97	35.367	9.617	35.5	9.5	4	35.375	9.625	5
98	37.696	11.922	37.5	12.0	30	37.625	11.875	59
99	37.042	11.370	37.0	11.5	21	37.125	11.375	43
100	36.600	8.233	36.5	8.0	18	36.625	8.125	30
101	37.750	10.150	38.0	10.5	38	37.875	9.625	65
102	38.147	10.329	38.0	10.5	38	38.125	10.375	69
103	38.108	10.245	38.0	10.0	39	38.125	10.375	69
104	37.312	11.689	37.5	11.5	31	37.375	11.625	52

Table B.3 Annual Maximum Rainfall of ECMWF for 0.5 by 0.5 grid Size (mm)

ECMWF- 1 day for 0.5 by 0.5 grid Size, year 1983-2012											
Grid No.	1	2	3	4	5	6	7	8	9	10	11
Longitude	34.5	34.5	35.0	35.5	35.5	35.5	36.0	36.0	36.0	36.0	36.0
Latitude	10.0	9.5	10.0	9.5	9.0	8.0	10.5	9.5	9.0	8.5	8.0
1983	116.856	66.555	86.172	80.055	54.750	33.477	61.870	64.704	53.021	53.214	43.336
1984	44.798	33.613	39.662	49.178	29.388	41.634	43.191	58.972	50.932	33.919	34.723
1985	29.337	28.547	33.050	37.812	42.032	37.121	45.049	39.136	46.007	41.843	36.160
1986	42.510	52.753	45.694	90.050	82.523	46.944	45.687	87.136	85.986	58.925	34.776
1987	58.929	64.675	63.773	89.688	89.594	91.643	54.302	88.941	95.636	93.766	82.843
1988	43.076	48.104	47.046	52.588	41.698	38.750	42.175	47.779	46.943	46.808	43.039
1989	57.884	57.238	86.923	66.395	46.182	122.809	75.904	54.685	46.806	64.350	97.329
1990	68.557	73.903	90.930	124.552	98.792	55.493	64.445	129.611	119.224	83.133	56.942
1991	49.183	56.630	48.320	64.220	61.413	46.481	61.288	51.410	55.983	48.506	38.951
1992	31.987	38.203	43.513	59.891	38.383	31.571	58.674	78.753	63.653	35.832	25.130
1993	41.598	38.926	43.315	53.851	36.728	21.453	66.217	58.382	48.624	30.293	31.305
1994	21.576	28.477	29.925	50.656	32.875	42.547	45.855	59.360	47.698	35.687	38.391
1995	32.679	31.756	40.876	56.754	38.768	35.577	47.409	65.699	52.311	38.322	33.415
1996	79.715	64.903	90.634	75.606	62.987	96.243	64.666	75.653	63.900	80.066	94.853
1997	37.841	33.425	41.768	52.516	48.151	42.635	53.639	47.891	44.521	39.567	32.771
1998	118.564	59.679	102.062	54.920	52.863	33.622	86.951	49.624	46.272	39.379	29.364
1999	49.608	67.587	49.134	49.446	38.110	35.971	46.495	48.651	46.964	32.630	25.476
2000	45.581	47.545	57.273	87.943	77.732	64.153	76.457	109.700	105.712	92.561	62.565
2001	114.381	115.736	111.904	118.700	124.108	100.911	64.596	97.401	118.500	125.935	107.158
2002	28.782	26.864	46.141	46.191	36.829	52.432	58.634	57.448	62.989	53.953	49.612
2003	72.087	65.778	74.824	111.489	90.244	56.049	44.327	86.833	79.010	48.147	50.119
2004	36.534	31.707	51.862	82.873	38.069	26.420	63.316	51.125	46.509	31.158	24.645
2005	73.388	65.065	67.051	63.713	48.917	74.645	65.552	56.232	50.278	58.235	54.351
2006	70.555	76.636	91.831	72.439	47.514	71.250	52.806	61.499	61.977	68.617	64.515
2007	44.698	51.936	56.472	96.173	77.305	55.718	62.228	80.256	76.988	52.648	35.021
2008	58.412	63.525	56.316	48.068	59.697	56.119	80.835	53.496	63.052	57.424	43.928
2009	68.658	36.790	63.569	70.548	79.674	50.575	58.999	80.994	96.181	64.856	33.956
2010	60.507	61.837	54.168	56.489	48.884	66.075	84.057	68.025	47.730	43.032	52.681
2011	119.459	122.977	108.051	145.023	90.208	89.227	123.990	127.324	87.500	67.248	76.828
2012	48.339	49.483	42.724	116.084	141.376	73.779	68.439	96.382	147.447	107.498	75.565

….Con't											
Grid No.	12	13	14	15	16	17	18	19	20	21	22
Longitude	36.5	36.5	36.5	36.5	36.5	36.5	36.5	37.0	37.0	37.0	37.0
Latitude	11.5	11.0	10.0	9.5	9.0	8.5	8.0	12.5	12.0	11.5	11.0
1983	50.074	55.837	56.656	53.651	48.922	61.569	47.787	39.427	41.830	63.379	66.976
1984	58.732	48.454	50.099	58.194	61.352	48.756	36.446	87.627	74.785	70.721	60.530
1985	54.072	49.802	38.517	36.633	37.828	37.673	39.293	76.731	55.097	67.339	66.128
1986	62.612	48.301	53.920	73.686	61.253	49.602	36.184	38.041	44.199	48.654	51.264
1987	38.526	42.377	61.987	79.353	81.622	83.644	70.485	34.750	32.223	50.960	55.853
1988	66.257	47.806	49.484	50.528	45.114	46.833	44.556	56.976	61.576	65.482	54.400
1989	69.408	60.036	57.032	53.057	41.547	52.951	54.530	60.238	57.249	56.764	66.328
1990	47.901	58.997	93.146	122.099	101.310	69.361	50.771	29.721	38.772	54.857	64.534
1991	66.208	57.532	57.868	56.939	54.405	46.710	33.639	38.370	41.211	45.403	63.949
1992	47.748	57.651	72.974	83.163	64.584	41.182	29.618	56.082	50.424	46.272	63.202
1993	95.133	71.891	57.678	63.357	47.207	41.623	31.265	43.536	67.194	92.474	74.246
1994	54.511	46.396	54.745	60.835	39.091	34.949	30.973	36.696	51.488	62.694	56.611
1995	43.172	34.934	50.738	55.055	54.030	40.546	35.659	59.514	57.702	56.602	42.271
1996	45.724	51.414	52.263	68.820	56.519	64.951	80.774	32.403	33.596	33.167	42.785
1997	54.928	51.230	57.856	54.343	37.554	45.142	47.963	40.783	47.635	48.578	58.783
1998	70.329	83.798	63.717	57.300	48.987	42.560	31.648	167.665	137.705	81.977	58.634
1999	67.075	50.998	49.783	53.603	35.652	27.515	27.988	75.024	79.784	77.365	55.013
2000	64.736	68.459	78.806	114.294	113.237	103.170	71.783	49.084	51.830	49.891	73.161
2001	57.299	57.638	69.594	73.153	103.130	119.400	102.823	33.191	47.589	65.832	73.523
2002	41.045	32.484	50.536	53.126	59.486	58.706	36.525	51.729	43.316	38.827	48.063
2003	62.171	48.914	51.715	55.769	38.212	49.989	45.053	76.742	68.925	77.411	68.282
2004	39.869	47.179	55.822	57.084	43.240	33.482	36.094	54.787	56.586	53.606	37.926
2005	71.174	65.461	78.981	79.295	54.039	49.154	49.702	67.899	63.205	75.957	78.804
2006	62.784	68.186	45.893	66.633	59.576	57.228	55.239	47.793	49.225	51.495	68.924
2007	84.251	64.558	54.447	48.912	52.534	55.202	49.457	68.525	80.668	82.522	71.008
2008	78.420	69.251	69.014	50.301	50.330	46.424	43.967	74.963	80.651	78.884	51.414
2009	52.085	60.009	50.748	77.510	76.947	56.805	31.810	31.723	35.867	43.977	53.249
2010	46.458	69.110	72.564	72.443	44.165	38.366	40.278	55.940	51.351	44.973	59.602
2011	76.219	73.795	72.457	73.077	56.312	63.673	69.825	64.029	66.221	75.817	64.416
2012	78.631	73.497	48.624	71.335	66.141	77.923	72.922	48.348	50.906	65.100	73.097

Con't											
Grid No.	23	24	25	26	27	28	29	30	31	32	33
Longitude	37.0	37.0	37.0	37.0	37.0	37.0	37.5	37.5	37.5	37.5	37.5
Latitude	10.5	10.0	9.5	9.0	8.5	8.0	12.5	12.0	11.5	11.0	10.5
1983	54.931	54.935	47.889	56.676	61.561	42.102	48.358	55.596	62.416	58.445	47.484
1984	43.000	36.223	69.274	101.318	64.863	49.003	56.413	51.877	49.402	61.820	45.985
1985	64.544	55.991	54.562	50.695	38.040	48.995	65.896	60.585	61.181	65.729	68.992
1986	47.966	51.156	51.631	46.985	44.501	46.169	32.558	34.453	37.646	43.037	38.265
1987	57.939	62.005	60.703	73.617	75.397	58.614	27.422	28.960	39.285	56.604	47.078
1988	51.082	50.894	71.196	59.723	53.811	47.598	48.320	49.066	55.544	49.476	55.881
1989	63.281	52.006	50.011	41.135	45.209	48.605	44.147	44.342	44.988	60.891	59.876
1990	59.696	76.665	107.144	90.106	55.878	47.980	29.137	40.350	67.314	67.094	57.800
1991	64.836	59.702	63.723	64.412	52.587	34.747	43.564	49.294	53.203	66.531	70.519
1992	61.689	57.743	70.053	56.123	32.513	34.782	39.487	42.300	37.135	52.571	45.054
1993	77.409	49.578	59.038	48.858	40.777	33.854	51.681	50.066	67.424	48.901	69.615
1994	59.705	78.569	64.814	50.222	40.705	32.521	29.854	44.481	45.580	44.097	67.244
1995	54.660	59.512	53.529	54.893	39.434	34.413	59.617	58.863	43.371	44.369	55.939
1996	50.095	56.534	67.044	63.856	66.470	64.156	37.148	38.386	35.074	32.034	37.147
1997	67.181	68.351	58.385	43.196	50.695	55.401	63.904	36.233	30.154	47.956	65.571
1998	63.337	58.612	65.566	51.426	40.813	42.178	164.246	130.115	74.635	47.260	44.483
1999	49.740	54.279	58.762	37.657	33.219	34.223	40.476	59.623	56.586	45.148	49.703
2000	102.612	95.133	98.936	123.193	109.231	87.012	50.709	45.270	47.059	57.729	92.199
2001	64.957	68.071	67.304	92.588	96.563	84.439	40.471	47.745	76.531	74.524	68.037
2002	41.417	37.753	40.266	56.650	47.829	36.656	62.258	52.869	35.435	40.754	42.762
2003	50.830	50.701	53.625	51.445	40.214	44.884	67.270	58.892	77.417	72.920	49.967
2004	49.105	51.447	56.026	47.817	43.017	44.133	43.618	49.887	56.041	35.466	32.733
2005	74.383	86.897	97.826	59.838	42.469	52.238	83.078	80.572	69.046	66.705	61.885
2006	66.219	45.139	65.821	60.662	46.338	46.850	60.987	62.959	68.681	71.585	60.230
2007	69.077	69.207	70.460	61.604	59.241	57.971	68.168	79.830	79.960	68.372	65.822
2008	60.084	57.719	66.678	49.461	42.235	48.080	58.382	65.238	68.390	51.204	48.091
2009	53.727	59.123	68.895	68.963	43.448	35.486	47.055	45.289	35.770	47.010	49.665
2010	59.344	47.509	49.777	39.979	35.690	41.973	76.726	74.875	65.201	56.898	39.588
2011	54.852	42.825	61.575	61.138	49.500	57.798	54.593	60.691	45.179	50.082	53.641
2012	63.751	46.615	72.376	71.671	57.430	45.717	50.131	48.046	61.921	64.717	57.807

….Con't											
Grid No.	34	35	36	37	38	39	40	41	42	43	44
Longitude	37.5	37.5	38.0	38.0	38.0	38.0	38.0	38.0	38.5	38.5	38.5
Latitude	9.5	8.0	12.0	11.0	10.5	10.0	9.5	9.0	11.5	11.0	10.5
1983	39.607	40.356	80.779	61.999	68.775	60.308	38.573	44.559	99.457	58.120	70.679
1984	56.496	40.705	47.296	63.974	62.077	58.628	50.502	43.856	41.387	64.002	57.289
1985	71.295	44.784	60.031	54.391	65.032	68.077	56.241	43.070	36.977	45.224	53.635
1986	43.058	47.642	37.070	44.664	49.039	41.451	45.801	46.713	64.299	59.491	50.568
1987	43.965	46.992	31.989	31.130	42.153	37.627	33.968	47.936	31.231	30.834	32.462
1988	60.539	40.249	52.493	55.957	77.013	72.674	58.500	58.342	93.651	60.630	77.483
1989	42.857	45.280	44.610	46.741	56.404	54.254	50.622	48.102	51.209	43.997	48.100
1990	84.561	34.311	48.406	69.277	62.148	50.017	60.916	49.723	66.009	61.317	57.010
1991	55.851	43.040	61.645	57.709	71.728	59.564	58.420	62.683	107.709	53.063	57.701
1992	61.245	36.052	41.902	47.563	50.168	46.908	58.356	48.467	64.891	57.263	70.799
1993	57.884	34.152	38.358	40.423	61.888	55.784	55.527	34.530	72.598	63.370	90.795
1994	87.147	26.359	39.684	34.900	44.524	89.714	63.480	58.437	39.520	42.562	47.725
1995	51.325	28.179	70.451	42.583	60.393	65.432	44.497	42.667	61.285	52.585	65.049
1996	70.847	49.796	40.615	42.784	44.238	65.915	69.192	52.135	45.243	48.871	52.867
1997	62.948	36.733	55.528	43.956	66.720	74.457	57.034	45.690	77.909	56.533	55.592
1998	49.476	50.848	125.290	45.219	43.752	39.602	41.113	50.495	71.003	54.124	51.721
1999	56.529	22.762	38.661	41.919	48.537	54.054	50.627	35.873	50.185	49.831	52.103
2000	78.700	77.763	45.894	52.427	49.398	44.051	57.916	71.665	50.393	46.548	47.229
2001	60.230	57.672	43.718	77.101	62.909	43.340	45.572	47.612	56.906	60.763	62.241
2002	41.117	29.266	84.130	42.676	52.096	46.781	35.891	33.758	77.057	51.833	61.174
2003	41.489	40.540	46.718	49.627	45.809	34.635	36.626	37.572	47.858	45.796	60.778
2004	48.706	41.812	46.583	43.754	48.329	56.237	52.078	44.407	55.718	45.198	54.703
2005	71.311	59.499	79.389	62.475	55.058	42.576	44.228	44.922	81.182	65.077	53.880
2006	48.911	47.515	70.055	81.187	76.848	58.078	51.622	39.008	76.583	74.657	78.831
2007	91.162	51.422	63.353	58.746	63.834	83.860	95.844	73.809	64.370	46.132	55.743
2008	66.043	44.066	51.310	41.816	43.674	46.856	41.958	43.551	50.308	35.806	46.298
2009	56.515	52.929	54.830	46.585	50.215	46.432	43.709	36.870	40.323	46.080	44.550
2010	43.646	38.530	94.460	61.477	55.007	57.960	46.626	32.597	95.449	65.436	58.752
2011	53.593	45.854	54.204	59.351	72.628	58.360	42.261	46.165	47.218	64.945	71.789
2012	44.686	49.069	45.860	54.493	45.303	37.464	35.287	36.022	66.125	51.986	44.360

….Con't													
Grid No.	45	46	47	48	49	50	51	52	53	54	55	56	57
Longitude	38.5	38.5	38.5	39	39	39	39.5	39.5	39.5	39.5	39.5	40	40
Latitude	10	9.5	9	12	11.5	10	11.5	11	10.5	9.5	9	11	9
1983	63.735	41.440	61.615	68.588	50.289	36.917	45.313	37.166	45.799	31.637	36.337	27.929	35.560
1984	44.839	54.779	54.820	30.601	33.298	32.995	33.281	47.130	47.113	32.365	30.291	33.919	26.824
1985	52.588	55.563	50.903	32.945	33.169	37.229	33.557	51.270	45.687	44.458	41.113	43.653	33.282
1986	51.449	45.328	57.098	55.062	60.695	38.446	65.698	60.751	63.349	43.886	42.153	38.031	27.688
1987	33.625	31.653	39.765	22.718	32.828	27.104	25.790	30.649	28.364	34.982	40.300	22.118	39.031
1988	77.264	57.334	55.287	69.744	69.543	55.730	81.401	66.480	50.760	43.379	39.351	53.862	24.975
1989	57.477	52.397	51.127	29.824	37.382	37.631	38.119	45.505	49.683	48.671	54.835	31.822	40.772
1990	46.974	58.457	46.145	36.561	51.385	38.323	37.455	53.259	60.802	28.514	28.707	72.512	33.591
1991	48.174	62.415	62.623	36.197	49.055	27.738	38.155	43.298	66.729	39.910	32.473	33.290	28.780
1992	59.418	60.711	51.541	42.519	55.990	37.447	40.392	58.769	61.800	51.035	51.558	36.968	48.427
1993	76.008	51.248	36.251	77.623	90.724	56.812	109.280	119.950	121.160	41.341	39.282	121.800	61.212
1994	56.537	61.128	60.058	43.574	45.927	43.662	53.605	64.226	59.609	33.785	61.548	51.927	54.091
1995	56.994	52.100	54.914	64.267	53.925	36.386	55.781	49.645	40.454	31.903	32.721	48.113	41.441
1996	65.260	61.909	54.057	37.861	46.988	50.476	45.743	40.104	45.276	35.693	38.495	31.840	48.097
1997	63.708	56.137	47.072	35.533	42.047	41.017	40.505	53.175	47.909	39.053	41.885	37.961	27.437
1998	49.479	40.559	45.879	70.386	60.339	49.017	66.081	61.124	51.339	38.356	42.494	50.723	30.935
1999	52.598	47.858	41.405	42.861	48.396	39.162	50.739	53.410	54.560	28.083	27.186	43.208	20.272
2000	46.904	47.312	52.703	78.783	53.155	39.574	64.529	40.664	52.267	36.359	44.343	58.816	58.344
2001	44.273	43.842	55.526	46.911	55.943	33.138	73.550	67.405	54.974	29.897	39.917	56.586	40.632
2002	51.864	42.809	51.191	107.330	137.040	37.735	161.960	149.620	65.998	28.177	22.949	176.080	20.616
2003	49.590	44.489	55.463	39.316	45.950	35.839	56.348	51.963	47.183	31.527	30.185	48.396	21.233
2004	49.480	56.469	45.141	42.184	41.639	33.844	43.592	46.975	42.923	40.240	51.772	38.317	35.185
2005	44.354	49.663	45.322	53.339	77.333	39.365	61.587	60.436	47.042	38.203	29.819	47.559	23.519
2006	66.588	54.260	51.513	58.524	84.742	50.951	84.177	67.633	48.301	37.286	38.522	51.096	27.339
2007	73.463	98.466	79.872	52.252	51.166	55.850	48.908	45.611	50.973	60.411	55.957	45.597	36.332
2008	53.819	62.564	66.396	44.283	52.174	43.047	53.331	47.682	52.738	29.336	24.901	44.909	20.844
2009	57.042	50.733	45.881	50.287	36.085	44.231	37.788	58.324	53.128	31.742	32.884	56.401	39.984
2010	60.373	43.037	28.543	62.462	73.430	34.730	53.287	49.778	34.921	26.752	35.270	32.862	23.795
2011	60.086	48.251	51.543	42.653	41.540	38.170	39.816	45.187	39.833	31.566	37.779	40.319	24.843
2012	37.970	35.666	43.526	39.204	55.686	29.557	42.248	43.853	43.177	40.474	44.981	33.630	47.482

ECMWF- 2 day for 0.5 by 0.5 grid Size, year 1983-2012														
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Longitude	34.5	34.5	35.0	35.5	35.5	35.5	36.0	36.0	36.0	36.0	36.0	36.5	36.5	36.5
Latitude	10.0	9.5	10.0	9.5	9.0	8.0	10.5	9.5	9.0	8.5	8.0	11.5	11.0	10.0
1983	136.2	90.5	130.545	139.736	74.593	41.913	71.773	89.029	65.610	71.582	62.573	60.889	55.837	71.484
1984	46.8	36.7	42.143	54.559	45.456	41.634	52.665	63.114	55.959	45.333	38.911	68.292	49.910	52.356
1985	35.0	28.5	37.900	38.198	42.962	46.762	59.908	47.822	47.526	44.591	47.810	54.072	49.802	62.875
1986	80.5	85.2	73.817	95.734	86.293	55.650	57.985	88.988	85.986	64.821	54.243	74.290	56.711	64.820
1987	74.1	76.1	81.279	99.935	98.974	108.761	58.484	98.355	105.443	106.452	102.424	47.675	51.726	69.895
1988	47.5	69.2	58.305	68.629	55.866	57.532	66.578	63.480	53.907	54.449	71.790	71.266	61.034	67.266
1989	68.1	70.7	96.506	83.011	68.590	145.330	90.328	69.681	73.386	91.724	116.695	87.313	73.143	81.696
1990	75.8	84.1	99.942	139.883	119.609	78.268	75.644	144.242	139.877	110.495	69.517	61.662	75.757	106.055
1991	55.1	65.4	59.962	87.913	89.752	78.233	69.520	75.446	87.403	83.066	71.575	76.554	67.072	63.390
1992	43.1	52.9	51.590	78.208	56.249	43.289	67.965	102.662	89.203	60.711	40.534	58.662	60.183	93.370
1993	65.5	55.9	54.496	59.827	43.447	42.302	72.855	74.704	65.691	44.687	44.327	111.524	87.142	74.846
1994	37.4	30.6	49.002	58.552	41.094	68.295	58.289	59.360	48.665	53.914	63.783	67.913	60.201	57.038
1995	47.8	48.1	47.776	62.275	64.977	55.056	61.606	67.385	79.581	69.319	56.003	61.324	53.728	50.738
1996	90.1	84.1	106.178	96.864	81.173	100.259	89.136	90.689	84.005	80.066	97.155	59.192	69.458	75.086
1997	47.9	40.7	67.322	58.575	50.959	52.022	73.530	58.004	53.799	60.093	52.156	60.491	72.839	59.698
1998	118.6	59.7	107.990	89.540	92.486	49.445	99.788	84.693	80.977	70.751	54.731	82.793	94.277	70.690
1999	55.6	92.6	56.247	60.494	53.625	55.157	50.421	61.175	60.911	48.140	40.674	71.517	55.886	62.541
2000	77.3	79.4	72.224	103.863	98.040	81.117	86.678	120.858	121.899	111.942	87.582	84.401	82.709	85.390
2001	131.6	118.7	117.320	123.411	124.108	100.911	65.034	101.806	118.500	125.935	107.158	58.501	58.154	71.482
2002	43.6	46.4	54.914	47.849	40.491	55.286	64.270	61.051	62.989	53.953	49.612	56.321	57.294	63.622
2003	78.2	65.8	74.824	112.350	92.307	56.049	64.056	86.852	80.961	48.661	59.356	87.554	58.718	56.820
2004	36.5	31.7	51.862	96.477	66.008	26.420	63.316	57.857	55.164	39.676	35.162	51.192	54.740	67.899
2005	73.4	72.8	79.983	94.888	74.656	103.912	85.653	109.910	95.170	81.972	96.240	86.627	77.295	118.505
2006	74.7	76.6	98.503	78.068	56.775	79.397	65.621	78.254	78.817	78.218	70.168	72.252	74.351	60.204
2007	44.7	51.9	61.555	118.269	105.710	62.552	68.214	94.652	101.160	77.162	49.882	84.251	74.168	60.815
2008	58.4	67.3	57.920	65.613	76.667	70.114	82.072	62.555	75.316	68.210	55.258	102.567	70.403	71.494
2009	73.2	43.8	79.032	70.548	79.674	77.612	79.062	80.994	96.181	64.856	57.360	68.121	74.144	55.915
2010	63.3	78.4	63.852	67.909	63.511	113.529	86.790	69.270	55.212	64.538	84.536	50.095	71.688	72.564
2011	126.0	129.2	116.210	145.023	92.993	103.243	126.007	127.324	88.665	76.474	94.158	78.890	78.828	80.529
2012	48.3	62.0	55.660	145.795	179.621	129.574	85.987	121.055	188.924	167.904	148.689	99.157	94.813	79.315

….Con't														
Grid No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Longitude	36.5	36.5	36.5	36.5	37	37	37	37	37	37	37	37	37	37
Latitude	9.5	9	8.5	8	12.5	12	11.5	11	10.5	10	9.5	9	8.5	8
1983	66.843	62.08	77.821	63.166	47.59	57.971	70.032	66.976	68.74	74.361	64.719	69.946	74.366	51.496
1984	65.196	77.196	58.224	46.886	87.627	74.785	71.296	62.309	48.378	45.92	83.084	118.14	74.082	56.577
1985	54.459	37.828	39.963	49.317	76.731	55.097	69.247	69.792	71.751	64.52	61.937	54.582	43.499	57.822
1986	77.417	63.944	60.888	58.6	38.041	58.306	64.52	54.92	52.989	66.515	71.542	73.673	60.998	55.527
1987	87.027	88.494	94.565	89.482	49.89	43.854	63.19	64.992	74.9	79.869	71.446	78.007	83.486	71.339
1988	62.806	49.57	50.683	64.134	63.212	67.236	69.842	72.06	75.14	68.906	82.727	67.299	56.542	55.185
1989	63.296	48.008	55.642	61.986	60.238	57.249	80.864	86.587	90.211	73.795	54.266	57.766	52.718	62.19
1990	135.91	115.97	86.341	68.264	36.632	43.449	62.97	85.231	72.684	88.873	120.58	103.48	75.513	65.105
1991	69.828	65.824	77.007	64.53	73.658	61.32	66.764	65.177	64.836	59.702	80.394	80.159	63.16	63.731
1992	110.98	92.664	68.925	46.309	68.838	60.429	51.622	67.024	72.888	74.084	99.018	85.635	58.014	51.667
1993	81.307	63.409	51.844	44.513	58.961	88.321	114.92	99.851	93.657	64.894	81.06	73.383	51.006	48.45
1994	60.835	43.471	50.257	51.907	44.524	63.068	87.124	76.346	66.591	88.646	76.497	51.409	43.302	41.291
1995	67.969	74.155	69.869	57.694	77.376	65.159	58.652	53.966	63.159	59.512	61.946	73.021	66.167	56.699
1996	79.053	82.601	83.209	82.722	45.322	50.656	46.141	68.55	80.964	79.007	102.6	121.5	108.15	88.044
1997	63.305	55.211	63.006	60.806	44.881	60.767	57.043	81.25	92.398	68.411	65.036	58.471	66.155	67.231
1998	93.429	86.567	76.472	55.761	184.22	153.68	94.236	80.837	76.91	66.861	92.445	87.89	73.364	62.24
1999	65.789	45.499	48.67	46.233	93.416	84.627	79.883	58.77	65.938	70.409	74.531	57.16	53.852	55.461
2000	122.66	124.7	118.99	94.052	61.52	72.112	83.311	90.398	102.61	95.133	103.24	136.91	126.55	108.29
2001	81.087	103.13	119.4	102.82	46.614	56.987	69.033	73.523	64.957	69.111	89.779	92.588	96.563	84.439
2002	54.394	59.486	58.706	45.071	62.118	54.994	48.342	78.233	73.807	58.684	45.249	56.65	47.829	50.81
2003	55.769	46.879	52.829	57.316	83.829	78.398	91.758	79.726	65.995	58.935	64.899	65.816	44.026	50.116
2004	67.052	52.367	42.449	42.115	61.443	64.498	64.737	52.032	66.376	69.011	73.178	56.846	49.971	50.571
2005	121.35	87.179	74.013	91.059	80.784	75.04	90.289	81.443	99.686	118.92	132.12	88.495	68.584	77.135
2006	85.605	77.693	71.636	62.033	54.061	49.225	54.291	76.851	70.301	54.648	85.972	80.89	65.795	57.974
2007	58.922	67.212	74.482	49.457	79.79	91.139	92.933	81.381	75.983	76.213	80.369	66.838	59.241	57.971
2008	56.65	57.249	53.97	54.248	92.497	92.226	82.001	69.597	64.133	60.879	77.864	57.937	51.273	56.13
2009	83.123	76.947	56.805	47.065	57.484	64.233	64.491	63.341	68.825	69.546	78.733	68.963	49.316	46.489
2010	72.443	53.481	58.467	59.804	55.94	51.351	45.188	62.334	63.546	57.608	54.798	50.748	51.634	57.198
2011	73.077	56.312	64.87	73.168	64.029	69.26	78.535	66.217	81.801	63.454	70.036	71.957	60.201	61.018
2012	76.499	90.158	123.34	121.56	69.358	81.307	99.932	104.04	97.627	79.093	81.31	80.861	63.567	51.705

….Con't														
Grid No.	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Longitude	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	38.0	38.0	38.0	38.0	38.0	38.5
Latitude	12.5	12.0	11.5	11.0	10.5	9.5	8.0	12.0	11.0	10.5	10.0	9.5	9.0	11.5
1983	57.3	70.4	83.2	67.3	52.8	53.4	49.4	93.7	70.0	68.8	64.9	42.5	55.3	115.5
1984	62.8	58.6	61.5	76.6	59.0	89.3	46.9	58.9	82.4	74.2	75.2	68.9	57.1	71.2
1985	65.9	63.6	66.9	76.0	81.5	84.9	56.5	60.0	67.4	82.5	87.2	70.2	52.0	57.9
1986	41.7	49.9	54.3	55.4	59.2	74.8	50.1	54.9	60.1	65.9	70.6	64.9	56.8	90.8
1987	46.2	40.5	50.6	69.1	63.5	55.7	58.1	50.8	47.7	54.8	42.9	39.2	53.2	55.6
1988	64.1	66.3	68.2	77.9	80.0	76.8	45.8	72.8	87.5	87.8	79.2	77.9	75.0	97.9
1989	53.0	55.1	73.6	89.7	84.2	56.8	75.6	59.6	80.1	87.6	74.9	56.8	55.3	68.3
1990	39.9	46.1	75.6	78.7	74.8	88.5	45.9	53.4	88.1	88.8	59.0	64.3	51.8	73.9
1991	66.1	63.2	92.1	81.6	77.0	64.5	47.9	105.9	110.3	81.9	69.3	76.3	76.9	170.5
1992	60.5	63.3	66.6	67.7	64.2	73.5	52.2	79.3	69.6	59.8	61.2	71.6	60.9	94.2
1993	67.5	70.4	94.1	77.9	87.6	78.6	45.0	53.0	64.0	103.9	96.2	80.5	55.1	88.6
1994	34.7	59.0	72.5	71.4	78.2	102.1	38.0	49.6	67.4	61.8	107.8	78.5	60.0	67.9
1995	72.3	73.3	53.4	56.5	66.3	51.3	42.0	83.0	62.0	73.3	65.4	53.5	54.0	84.5
1996	48.2	51.4	50.0	45.5	62.9	96.8	79.2	50.6	55.6	63.8	83.0	77.3	96.8	68.2
1997	68.5	48.8	36.3	72.1	87.0	65.1	48.6	71.1	54.0	70.6	78.4	62.0	51.7	81.9
1998	182.8	146.6	88.6	61.2	61.2	70.1	62.8	146.8	66.2	65.7	49.6	57.3	60.7	93.6
1999	62.5	65.2	59.7	61.1	65.8	79.2	37.4	70.0	58.8	63.5	74.4	76.3	62.9	64.0
2000	59.7	78.5	79.6	78.1	96.6	79.8	100.8	74.7	69.2	57.5	50.2	57.9	80.6	73.8
2001	70.6	60.1	82.1	78.1	68.2	81.3	57.7	75.5	86.6	64.4	55.3	63.8	65.7	71.9
2002	70.9	65.1	56.9	57.8	59.9	44.4	49.4	102.6	61.4	56.0	48.6	40.4	39.8	118.8
2003	82.9	68.3	93.6	89.2	64.0	57.8	42.0	61.4	66.1	56.8	50.9	55.8	46.7	69.3
2004	52.5	59.8	73.8	57.4	50.5	69.6	49.7	63.9	62.5	78.8	76.7	69.0	61.1	76.9
2005	100.2	96.5	81.1	80.0	86.0	103.9	73.8	100.3	75.1	71.6	70.2	70.5	74.2	88.7
2006	68.0	63.0	87.5	83.4	67.2	71.1	48.4	70.1	97.8	87.8	58.5	60.6	51.2	99.9
2007	79.7	92.1	91.1	79.8	81.3	103.1	51.4	93.8	72.5	103.3	101.2	109.6	88.1	96.6
2008	72.2	77.2	74.9	66.9	54.4	84.4	50.2	68.8	73.2	73.8	68.2	60.9	64.3	76.9
2009	56.3	61.1	56.3	65.5	63.2	76.9	78.3	63.0	64.6	75.0	60.9	65.9	49.8	58.1
2010	84.5	82.9	73.4	56.9	55.0	54.4	53.3	112.2	72.5	56.1	66.7	54.1	34.4	121.5
2011	61.3	69.2	55.7	81.9	97.1	63.6	66.9	69.1	79.5	105.7	70.8	50.9	67.5	65.0
2012	64.3	85.6	102.2	98.1	91.0	55.0	63.5	78.0	84.6	65.7	60.1	57.6	56.1	76.4

….Con't															
Grid No.	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Longitude	38.5	38.5	38.5	38.5	38.5	39.0	39.0	39.0	39.5	39.5	39.5	39.5	39.5	40.0	40.0
Latitude	11.0	10.5	10.0	9.5	9.0	12.0	11.5	10.0	11.5	11.0	10.5	9.5	9.0	11.0	9.0
1983	75.6	73.6	64.5	47.9	68.1	85.8	59.9	46.0	51.2	43.1	53.1	42.7	45.7	33.0	42.0
1984	78.5	65.8	59.0	72.5	56.7	51.2	49.5	39.9	45.1	66.9	63.7	41.9	47.8	38.7	44.5
1985	67.1	71.9	62.6	64.2	61.9	37.6	52.9	46.5	52.7	63.6	61.9	49.5	49.3	59.5	39.0
1986	82.9	60.9	58.8	56.1	59.4	82.8	103.3	56.5	104.0	107.1	102.9	65.9	62.9	60.1	41.1
1987	52.2	49.9	38.8	45.4	48.5	40.0	48.2	38.7	45.2	52.3	51.2	55.2	64.6	35.9	65.3
1988	96.6	99.4	87.4	73.7	66.2	83.9	88.9	75.0	109.0	96.8	83.7	59.9	50.7	82.9	33.7
1989	60.6	57.9	64.7	57.3	57.5	40.2	40.6	42.4	50.3	50.1	54.9	58.0	62.4	50.0	52.4
1990	86.9	74.7	49.5	61.5	60.2	43.5	60.1	38.3	47.8	86.8	103.8	39.2	37.9	115.0	44.2
1991	83.1	66.8	66.8	66.0	79.6	59.6	62.4	53.2	57.7	66.8	83.6	60.9	58.7	40.7	53.1
1992	75.0	76.8	59.4	71.9	67.6	64.3	78.7	50.0	58.6	70.0	73.8	65.8	63.8	45.9	54.4
1993	101.4	156.8	136.8	98.3	55.0	90.6	101.7	100.0	120.5	130.2	155.7	69.4	53.7	133.9	100.2
1994	64.7	77.0	65.4	78.0	75.5	53.3	60.2	52.8	70.0	80.4	87.4	61.8	94.8	84.0	92.0
1995	75.6	75.6	57.3	60.9	66.6	73.5	74.2	38.7	71.2	73.2	66.9	47.2	46.8	70.0	57.2
1996	69.2	66.7	80.8	72.4	74.5	57.5	66.7	66.2	75.3	60.9	72.2	53.1	66.6	48.9	82.3
1997	67.3	68.9	69.1	65.1	56.8	47.7	63.6	49.4	45.6	58.8	54.3	54.7	52.9	55.0	42.9
1998	81.3	61.4	53.0	54.0	56.2	87.3	89.2	55.5	93.2	100.5	80.6	57.2	51.6	83.2	37.3
1999	60.6	69.0	70.9	76.0	76.6	71.8	65.9	61.4	60.9	74.0	78.3	48.6	45.1	60.9	30.2
2000	58.6	58.1	49.5	48.8	58.5	133.8	62.2	44.5	80.1	56.6	74.5	67.3	56.4	74.7	66.0
2001	74.6	62.2	58.7	59.9	63.6	65.7	80.5	49.1	103.0	100.0	87.6	47.6	53.0	81.8	40.6
2002	57.5	61.2	55.2	44.9	51.2	155.7	174.0	42.9	214.9	185.2	77.2	31.9	41.3	219.8	40.1
2003	70.5	70.7	58.5	56.7	57.7	50.7	75.1	52.2	76.9	86.4	82.7	48.7	42.8	65.2	30.3
2004	60.9	67.5	66.5	63.0	53.4	47.8	55.7	43.7	49.0	51.9	64.1	42.9	53.7	53.3	39.5
2005	76.5	69.4	54.0	74.6	72.1	64.6	91.9	58.2	94.2	101.2	87.8	67.0	54.2	91.6	35.0
2006	74.9	78.8	68.4	55.4	54.7	78.3	112.6	60.3	113.7	100.0	77.1	41.8	43.4	76.4	35.4
2007	70.8	86.3	103.4	117.1	100.2	97.4	81.2	76.8	56.4	70.1	75.9	88.3	80.2	60.1	45.8
2008	61.4	65.4	66.4	62.6	69.2	81.8	86.3	51.3	98.3	80.1	77.0	48.3	42.0	83.9	36.0
2009	65.5	58.7	63.9	59.2	65.3	59.5	56.0	51.8	64.7	90.4	81.3	52.5	50.2	98.3	40.0
2010	83.5	67.9	66.6	48.0	42.6	88.4	105.9	41.0	84.6	80.1	56.9	30.0	45.1	50.4	34.3
2011	64.9	81.5	64.9	58.6	67.0	59.9	57.2	42.4	53.8	56.5	60.6	53.4	61.8	79.5	42.6
2012	67.0	65.5	62.7	61.4	52.7	54.3	64.2	46.9	61.5	63.8	73.0	56.4	64.9	51.4	59.8

ECMWF- 3 day for 0.5 by 0.5 grid Size, year 1983-2012														
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Longitude	34.5	34.5	35	35.5	35.5	35.5	36	36	36	36	36	36.5	36.5	36.5
Latitude	10	9.5	10	9.5	9	8	10.5	9.5	9	8.5	8	11.5	11	10
1983	136.2	90.8	132.1	146.2	79.1	44.0	82.2	111.6	85.2	73.0	60.7	65.9	73.4	85.3
1984	46.8	36.7	42.8	60.0	52.5	50.1	63.6	66.8	61.2	50.0	46.6	83.2	65.4	61.7
1985	35.0	28.5	41.1	38.2	43.0	47.9	63.0	47.8	47.8	44.6	51.5	76.4	70.4	62.9
1986	98.1	90.6	99.6	96.9	86.3	58.7	69.4	89.0	86.0	64.8	54.2	80.5	64.5	55.4
1987	88.8	103.1	86.8	97.8	94.7	91.6	62.6	88.9	95.6	93.8	82.8	56.2	52.5	67.1
1988	60.2	69.2	62.8	70.2	63.8	68.7	71.4	67.3	76.7	68.6	76.4	71.3	66.7	74.1
1989	69.8	76.5	96.5	84.8	70.0	149.1	104.5	88.5	78.6	92.4	118.9	91.0	94.9	82.7
1990	78.7	86.5	93.9	128.4	106.6	62.7	111.6	134.9	126.9	92.0	77.3	86.3	102.2	106.5
1991	55.1	65.4	60.0	95.1	89.8	78.2	83.8	92.0	98.6	87.6	71.6	128.0	88.8	81.6
1992	43.1	54.6	52.2	68.0	76.3	65.6	92.0	82.8	79.9	81.7	58.0	87.8	96.1	81.8
1993	61.8	66.9	49.0	67.0	47.4	49.7	75.6	78.1	67.3	50.8	59.5	111.5	87.7	75.5
1994	48.3	39.5	57.3	68.8	53.1	84.1	63.2	77.4	71.1	65.1	71.7	77.6	63.1	67.4
1995	50.6	53.3	58.9	68.2	70.4	62.2	61.6	71.6	85.1	74.2	61.1	61.3	53.7	56.9
1996	79.7	82.5	96.8	88.1	85.0	109.8	80.1	82.5	75.9	84.6	102.6	64.6	80.9	86.3
1997	53.4	58.3	75.9	88.2	81.1	58.4	68.3	77.4	82.5	65.6	53.7	54.9	68.4	71.8
1998	138.7	79.7	132.0	104.6	92.9	67.8	116.7	88.9	87.4	76.6	69.8	93.6	96.6	75.0
1999	63.6	70.6	60.4	59.6	56.9	61.0	79.2	61.3	62.9	51.0	45.9	76.8	57.3	62.5
2000	86.9	94.7	90.8	105.2	100.0	88.0	117.5	123.2	125.4	113.4	91.7	107.8	113.4	103.8
2001	131.6	118.7	117.3	123.4	124.1	100.9	76.9	101.8	118.5	125.9	107.2	88.0	86.4	80.4
2002	40.2	41.4	54.9	47.8	47.6	65.2	64.3	67.3	70.6	60.8	63.1	70.1	57.3	63.6
2003	78.2	66.1	75.1	114.5	94.3	72.2	72.1	88.2	82.8	66.6	75.9	107.4	70.3	59.4
2004	40.6	36.4	58.6	86.5	54.0	38.0	86.4	57.9	58.7	44.0	44.3	52.5	67.8	67.9
2005	73.4	78.1	86.6	78.3	79.9	112.9	95.8	70.9	70.2	90.8	107.9	92.6	97.1	94.5
2006	74.5	76.7	104.9	87.2	71.4	86.5	81.4	97.3	101.2	97.7	83.4	74.8	83.1	75.8
2007	62.2	60.2	71.3	119.9	109.3	78.3	75.7	101.0	108.2	80.8	49.9	100.8	94.6	70.1
2008	86.3	81.0	91.4	89.6	76.7	70.3	111.1	72.0	75.3	68.2	52.8	108.2	100.4	79.8
2009	74.0	77.8	75.2	81.4	88.9	85.1	71.3	91.4	106.0	75.0	68.3	82.1	89.4	62.7
2010	86.3	109.8	77.8	87.8	98.9	132.1	122.4	92.7	82.0	88.3	103.8	91.3	98.5	89.6
2011	120.4	124.3	127.3	179.0	99.6	126.1	137.5	174.0	129.1	106.1	119.6	88.9	94.1	97.1
2012	58.6	64.2	61.9	152.7	182.6	133.6	93.4	126.6	192.5	169.9	152.2	105.2	104.4	82.1

….Con't														
Grid No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Longitude	36.5	36.5	36.5	36.5	37	37	37	37	37	37	37	37	37	37
Latitude	9.5	9	8.5	8	12.5	12	11.5	11	10.5	10	9.5	9	8.5	8
1983	89.9	84.8	79.2	62.8	56.2	58.3	78.8	81.2	84.0	94.2	87.7	86.6	81.4	57.8
1984	65.8	69.5	58.7	49.4	109.3	95.6	97.0	78.3	63.4	51.9	70.4	112.0	75.7	66.0
1985	54.5	49.9	53.4	49.3	84.1	65.9	98.6	94.9	85.2	67.2	60.0	65.5	54.4	57.8
1986	77.4	63.9	62.1	61.4	62.4	70.9	73.9	69.1	63.1	55.4	73.2	73.6	64.1	67.3
1987	79.4	81.6	83.6	73.1	39.2	47.1	64.2	69.5	77.1	80.9	71.4	73.6	75.4	59.8
1988	81.0	72.0	68.1	65.6	63.2	67.2	69.8	81.1	85.4	81.4	107.5	94.9	68.8	65.4
1989	86.2	72.1	71.8	64.6	74.7	75.4	88.0	101.2	96.4	73.8	72.1	70.4	63.6	72.1
1990	129.9	107.1	76.4	77.2	41.8	66.3	87.0	105.7	95.5	96.3	120.5	99.9	81.8	70.9
1991	79.0	79.7	84.1	65.9	74.7	78.3	84.0	93.7	88.4	79.2	80.3	78.9	70.3	63.8
1992	91.5	75.9	66.2	66.0	72.2	61.7	92.0	100.2	91.6	75.5	94.1	79.5	71.1	72.8
1993	81.3	63.4	54.8	55.9	61.4	88.3	116.7	101.6	97.9	67.6	84.7	73.4	55.8	61.5
1994	78.0	67.4	62.1	57.2	59.5	75.3	85.1	75.4	78.5	100.0	90.0	70.5	59.5	62.8
1995	71.1	76.4	71.8	60.3	73.8	75.1	80.9	66.7	63.2	60.0	64.1	75.3	67.8	58.5
1996	82.8	89.8	90.7	84.4	45.3	59.4	74.6	82.6	94.9	95.9	111.8	126.2	110.9	91.1
1997	76.1	60.7	71.3	58.1	60.0	53.8	55.3	88.0	96.2	82.2	82.8	68.1	69.0	64.9
1998	95.6	86.9	80.1	79.6	201.4	168.2	103.3	89.9	86.2	69.8	94.1	87.9	86.5	100.4
1999	65.8	46.5	50.4	48.1	99.9	84.6	81.9	78.6	66.2	70.4	74.5	57.1	49.6	49.3
2000	134.0	128.7	119.0	96.6	71.6	76.9	92.4	106.9	134.7	124.0	125.8	146.5	129.5	109.5
2001	89.9	103.1	119.4	102.8	64.8	78.1	95.6	101.9	92.8	79.5	99.0	97.3	96.6	84.4
2002	61.6	67.1	64.7	61.7	92.4	81.1	68.4	86.3	77.1	59.3	62.0	67.7	56.2	67.4
2003	60.3	57.4	61.3	63.3	117.5	112.5	103.7	94.4	83.3	66.2	76.2	77.8	53.5	54.9
2004	67.1	52.4	49.5	47.1	67.3	68.4	68.6	54.8	66.4	69.0	73.2	67.1	59.5	54.7
2005	95.0	68.7	77.8	98.7	86.9	79.1	95.9	127.5	113.6	105.4	119.7	75.4	70.4	79.9
2006	108.1	108.5	107.4	98.7	69.4	74.8	91.9	83.5	74.7	66.9	113.0	122.8	109.2	104.8
2007	74.0	78.0	81.2	60.3	70.7	83.4	98.8	102.9	86.2	81.9	87.1	81.4	71.6	69.6
2008	66.5	57.2	60.6	51.8	96.3	105.1	105.2	87.4	73.3	68.8	75.3	58.8	59.0	56.2
2009	91.7	90.2	64.7	49.1	70.6	74.2	84.5	103.1	84.7	76.0	99.0	98.9	64.1	54.9
2010	87.5	83.9	73.2	74.3	81.0	66.0	67.0	87.8	88.2	73.9	76.8	82.7	73.3	74.0
2011	120.3	97.2	76.3	96.7	79.6	89.3	85.0	92.3	107.7	82.0	77.5	81.3	73.0	68.5
2012	79.9	92.1	123.9	123.9	68.3	84.9	111.9	120.9	109.3	83.7	82.8	79.4	65.4	61.8

….Con't														
Grid No.	29	30	31	32	33	34	35	36	37	38	39	40	41	41
Longitude	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38	38	38	38	38	38	38
Latitude	12.5	12	11.5	11	10.5	9.5	8	12	11	10.5	10	9.5	9	9
1983	57.3	70.4	83.2	82.6	69.8	75.3	59.5	93.7	77.5	74.5	71.8	70.6	77.2	77.2
1984	75.9	75.5	94.0	76.6	59.6	89.3	66.4	80.5	84.3	75.1	75.2	69.8	65.3	65.3
1985	82.8	79.2	100.7	104.3	98.2	79.0	56.5	78.5	99.8	115.5	101.8	73.7	68.2	68.2
1986	64.4	64.3	68.4	70.2	55.9	96.8	60.7	68.4	91.9	68.8	70.1	92.5	79.1	79.1
1987	45.4	46.3	51.7	73.9	68.6	60.7	60.3	64.9	55.2	64.6	48.8	48.7	60.3	60.3
1988	74.2	69.6	74.8	87.1	90.7	101.1	51.2	80.3	96.5	97.3	97.3	90.2	84.0	84.0
1989	73.2	74.0	85.5	82.7	74.4	68.7	86.7	76.6	74.8	77.2	75.3	72.3	84.3	84.3
1990	49.5	75.7	105.1	104.5	89.1	103.5	53.8	83.0	105.3	94.1	75.7	77.3	64.0	64.0
1991	63.8	74.9	111.6	102.3	99.5	81.3	57.8	111.3	115.4	98.1	86.2	91.3	82.0	82.0
1992	63.6	66.4	83.6	88.3	80.6	75.8	60.9	85.5	82.3	73.6	68.5	76.6	66.6	66.6
1993	67.5	70.4	94.1	85.8	90.4	82.3	62.2	57.8	101.7	129.7	111.1	88.3	78.9	78.9
1994	49.6	63.9	61.0	60.4	94.4	112.9	56.4	55.0	58.0	77.5	120.5	84.8	81.0	81.0
1995	60.8	65.4	70.4	82.0	76.2	60.9	51.9	85.3	80.1	86.8	75.9	63.9	71.1	71.1
1996	65.1	70.8	73.1	72.5	78.9	102.5	80.8	62.6	89.1	86.6	92.1	86.4	96.9	96.9
1997	86.0	63.9	48.8	69.0	82.5	89.9	55.8	84.7	57.7	92.8	103.4	89.8	74.1	74.1
1998	198.2	158.6	94.8	72.5	71.8	70.3	101.6	156.3	81.5	64.4	53.2	61.8	78.7	78.7
1999	92.7	82.0	76.7	82.0	72.6	79.2	39.5	89.9	73.0	73.9	75.5	77.6	66.5	66.5
2000	81.8	86.5	91.7	97.3	122.8	105.8	104.4	89.1	84.7	82.3	74.2	79.8	93.2	93.2
2001	91.4	90.6	101.3	95.9	89.3	88.7	72.5	103.8	100.0	86.2	73.6	68.8	80.2	80.2
2002	94.6	86.2	79.4	69.8	67.2	53.3	65.6	111.5	79.7	72.2	54.2	49.3	42.4	42.4
2003	103.3	97.7	102.1	106.9	89.7	63.5	54.2	82.3	83.5	87.4	64.5	60.0	54.2	54.2
2004	61.9	67.0	78.6	63.3	51.0	64.7	57.3	74.9	88.6	83.3	77.1	66.0	73.5	73.5
2005	88.0	87.3	86.2	111.6	109.0	96.3	82.7	87.1	83.6	99.7	78.0	67.2	58.2	58.2
2006	77.3	78.8	108.2	121.3	87.8	97.4	95.9	87.0	137.9	102.0	79.6	79.4	87.8	87.8
2007	80.6	85.8	89.1	91.7	94.8	114.1	65.4	100.8	85.7	115.0	128.4	122.9	105.0	105.0
2008	83.4	92.8	102.9	90.0	76.6	78.6	52.7	72.8	83.7	89.7	84.2	75.0	66.8	66.8
2009	82.5	78.8	69.7	80.2	82.1	85.3	92.4	94.0	80.1	88.5	75.7	74.9	65.3	65.3
2010	91.6	85.8	73.4	64.2	60.1	54.9	76.9	118.0	74.1	59.4	66.3	50.9	48.5	48.5
2011	74.3	88.7	82.4	107.3	122.5	68.6	78.0	86.5	99.0	125.7	90.0	57.0	67.5	67.5
2012	64.3	90.6	123.7	121.0	107.5	72.9	66.6	95.0	110.2	80.5	63.1	53.9	56.9	56.9

....Con't																
Grid No.	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Longitude	38.5	38.5	38.5	38.5	38.5	38.5	39	39	39	39.5	39.5	39.5	39.5	39.5	40	40
Latitude	11.5	11	10.5	10	9.5	9	12	11.5	10	11.5	11	10.5	9.5	9	11	9
1983	115.5	96.1	93.2	77.5	74.0	93.9	87.5	67.6	64.1	58.5	64.3	75.7	64.7	59.1	37.3	49.5
1984	84.6	81.6	70.4	64.5	79.3	68.3	68.9	61.9	46.7	52.8	73.6	74.2	49.6	60.8	42.7	53.9
1985	78.3	99.6	113.2	95.9	75.8	70.8	51.8	77.7	65.9	80.4	91.5	87.1	56.7	61.8	90.9	55.6
1986	155.1	142.4	106.4	86.0	78.1	69.6	121.1	151.8	75.3	140.3	160.5	138.8	96.6	85.9	69.2	63.7
1987	83.4	62.8	57.8	47.6	60.5	61.8	45.4	45.8	44.7	59.3	70.1	73.7	57.5	73.6	53.7	74.2
1988	104.8	104.5	107.8	97.9	83.2	77.1	112.9	125.4	83.5	163.5	148.1	103.5	79.2	69.6	123.2	43.8
1989	71.8	74.4	77.7	87.6	80.1	83.8	40.0	51.7	64.3	58.3	70.9	86.9	77.3	73.0	66.0	69.6
1990	117.4	94.4	86.3	86.0	92.7	68.0	75.2	76.7	71.4	64.3	95.7	119.5	53.0	64.0	129.7	62.8
1991	170.5	83.1	82.3	79.5	74.7	72.9	59.6	82.6	66.5	57.4	69.8	101.3	72.8	72.9	40.8	68.4
1992	104.5	89.0	87.6	74.8	82.3	77.1	74.6	93.3	62.3	75.8	90.6	86.6	70.0	70.5	65.4	70.9
1993	122.8	130.2	189.6	161.5	117.3	86.7	90.6	122.1	118.6	122.6	154.5	189.1	91.5	70.5	173.4	137.9
1994	68.5	76.1	90.6	74.7	89.7	90.9	63.3	76.7	63.8	77.6	88.7	87.8	74.4	114.7	71.1	121.1
1995	105.0	106.3	91.8	67.6	77.3	86.6	87.7	94.4	55.8	81.4	106.5	106.4	60.7	59.8	76.0	62.6
1996	71.3	94.4	86.9	89.8	80.1	80.0	60.7	68.1	78.8	77.5	75.5	92.7	61.8	75.6	66.3	97.2
1997	81.9	74.2	84.5	99.4	96.9	83.0	72.8	88.2	89.9	66.0	76.7	80.8	93.7	94.1	66.8	70.4
1998	116.4	99.1	70.0	60.8	64.0	90.7	91.0	110.2	71.2	110.7	121.7	101.8	81.8	75.8	100.7	63.6
1999	87.4	87.7	75.6	73.4	80.6	82.7	71.8	81.6	68.1	73.6	88.8	95.3	69.4	56.4	66.4	44.2
2000	97.6	93.2	84.4	65.6	66.9	72.7	145.0	109.5	51.0	128.2	81.2	87.2	52.5	61.2	93.0	71.1
2001	80.1	84.8	84.5	67.7	62.4	75.1	66.7	71.5	56.5	86.1	78.0	67.8	52.0	52.2	64.9	40.9
2002	157.2	73.0	75.4	64.0	49.4	57.3	193.5	247.1	51.7	286.4	243.3	106.1	39.1	48.9	260.7	47.8
2003	85.7	83.1	85.2	69.2	61.7	60.3	67.7	95.2	56.7	92.4	109.3	100.2	57.8	65.4	65.2	42.5
2004	96.1	97.8	96.3	78.0	89.0	80.2	54.0	76.2	64.2	61.2	70.2	76.2	65.3	75.1	53.9	57.5
2005	100.7	87.7	89.4	75.9	66.4	68.5	79.0	106.8	61.8	87.6	80.2	73.3	54.7	62.7	68.6	58.5
2006	154.9	117.6	103.8	88.4	73.4	79.8	98.2	146.6	74.8	140.2	124.6	96.6	57.4	52.0	86.4	44.7
2007	104.9	84.2	112.2	134.6	133.5	122.7	102.0	81.7	88.6	64.9	99.8	111.0	102.4	93.5	88.2	53.7
2008	82.8	74.5	95.4	87.4	78.6	74.4	86.0	91.4	68.7	102.7	107.4	100.5	72.8	57.9	98.0	53.7
2009	76.8	82.4	94.0	84.3	73.1	78.8	81.9	74.9	61.8	67.7	95.3	90.8	66.6	65.5	103.9	47.2
2010	128.5	87.9	67.1	64.6	48.2	55.5	92.7	111.4	42.4	90.7	86.8	73.2	38.0	50.4	64.1	41.6
2011	74.4	87.4	94.1	75.2	63.9	92.2	59.9	72.1	54.8	70.6	82.7	69.7	62.2	56.5	87.6	53.2
2012	106.6	96.8	84.0	70.6	66.9	67.7	73.7	98.0	63.9	83.4	86.2	69.5	66.8	79.7	67.6	69.0

Table B.4 Annual Maximum Rainfall of ECWMF-With Bias Corrected for 0.5 by 0.5 grid Size (mm)

ECMWF- with bias corrected 1-day for 0.5 by 0.5 grid Size, year 1983-2012														
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Longitude	34.5	34.5	35	35.5	35.5	35.5	36	36	36	36	36	36.5	36.5	36.5
Latitude	10	9.5	10	9.5	9	8	10.5	9.5	9	8.5	8	11.5	11	10
1983	47.172	31.649	37.812	40.081	31.067	23.029	30.141	38.908	33.584	32.530	28.116	31.021	32.133	34.077
1984	44.798	33.613	39.662	49.178	26.439	27.353	27.235	58.972	50.932	23.837	27.006	32.341	28.953	50.099
1985	21.663	21.278	31.232	27.131	27.531	25.312	45.049	26.227	29.309	27.446	24.872	31.437	29.746	29.572
1986	26.813	30.916	28.103	45.780	42.729	28.422	27.971	44.595	44.128	33.350	23.574	34.803	30.333	32.847
1987	32.403	35.617	35.261	45.632	45.594	46.430	31.528	45.328	48.065	47.298	42.858	30.807	26.740	44.990
1988	27.006	28.831	28.458	30.357	26.481	26.435	27.595	30.100	28.605	28.551	27.028	38.450	30.112	30.862
1989	32.940	32.686	44.508	36.296	28.150	48.963	53.052	31.679	25.124	30.941	41.245	39.907	45.656	32.604
1990	39.512	42.005	50.160	67.136	54.032	55.493	36.162	69.778	64.377	46.385	56.942	28.988	33.379	51.245
1991	30.727	34.065	30.342	37.514	36.232	29.521	36.175	31.722	33.774	30.425	26.143	38.427	34.472	32.364
1992	22.336	25.082	28.195	35.540	25.886	22.166	34.989	44.294	41.676	24.721	19.444	28.927	32.848	41.569
1993	26.441	25.379	27.141	30.773	24.463	17.306	34.661	32.230	29.012	21.590	22.047	52.222	41.063	32.007
1994	17.698	20.756	24.560	30.085	29.781	28.509	31.063	33.521	39.892	33.815	25.111	33.112	29.483	31.703
1995	22.658	22.249	30.309	28.470	25.268	24.604	35.256	31.375	30.741	25.082	23.602	28.042	23.642	35.638
1996	38.769	34.259	47.975	38.916	36.950	52.770	34.186	42.827	37.367	44.919	52.084	27.435	29.965	32.104
1997	37.841	23.005	41.768	34.952	28.847	26.864	30.704	28.882	27.545	25.602	22.699	31.775	28.252	34.618
1998	47.687	29.429	42.690	35.125	27.179	23.072	41.849	43.922	38.199	28.020	21.457	37.854	37.076	35.239
1999	35.825	35.080	38.020	29.875	25.762	24.785	33.801	30.490	29.736	23.234	19.745	36.565	30.220	30.995
2000	29.119	29.996	34.355	48.706	43.810	35.411	43.207	59.506	57.492	50.958	36.757	37.751	39.467	44.320
2001	55.864	56.435	54.822	57.687	59.984	50.240	35.586	48.791	57.603	60.763	52.836	34.367	34.520	37.563
2002	23.324	26.864	28.283	28.303	24.506	30.305	33.236	30.544	30.503	27.543	29.353	26.213	23.166	30.037
2003	33.408	31.400	34.272	45.552	39.070	31.486	28.559	38.016	35.585	30.265	29.527	35.373	28.728	30.505
2004	32.441	26.524	27.324	36.789	25.027	19.532	31.771	31.595	29.533	22.527	18.922	26.558	29.019	33.702
2005	39.070	35.771	36.556	35.237	29.393	39.571	35.963	32.289	35.561	37.361	36.308	40.728	35.927	41.305
2006	35.983	37.831	42.512	37.103	42.917	36.195	39.362	36.271	43.342	35.394	34.139	30.436	37.005	29.258
2007	28.725	31.185	31.154	48.286	40.633	55.718	36.603	41.816	40.506	30.874	27.031	37.217	37.669	33.083
2008	44.227	57.275	42.577	35.348	33.654	31.509	42.049	32.656	33.689	31.926	27.390	41.361	37.426	37.332
2009	32.320	25.160	32.912	40.437	44.732	31.349	32.425	45.361	52.740	37.806	23.246	31.358	32.742	30.121
2010	47.568	45.554	51.887	39.897	34.190	48.136	84.057	45.218	37.738	39.820	34.085	46.458	69.110	59.751
2011	119.459	122.977	108.051	105.794	74.754	38.756	49.317	63.173	48.404	36.633	37.065	76.219	54.759	33.525
2012	26.002	34.342	23.700	46.940	54.507	43.340	39.458	40.955	56.308	44.343	34.505	44.236	41.814	30.478

….Con't														
Grid No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Longitude	36.5	36.5	36.5	36.5	37	37	37	37	37	37	37	37	37	37
Latitude	9.5	9	8.5	8	12.5	12	11.5	11	10.5	10	9.5	9	8.5	8
1983	32.726	30.611	36.303	30.104	25.582	26.530	35.105	36.526	31.776	33.302	31.019	34.086	36.300	28.279
1984	58.194	36.609	29.329	30.603	41.201	37.268	36.034	32.905	26.977	36.223	43.383	42.463	31.571	29.428
1985	25.089	25.634	25.563	26.735	40.404	31.842	36.669	36.191	35.565	32.194	31.630	30.100	24.963	32.260
1986	39.188	34.268	29.666	24.178	25.731	27.499	33.361	36.747	30.184	31.609	31.821	29.746	28.637	29.382
1987	56.341	42.366	43.181	37.916	24.223	26.218	50.960	55.853	37.628	39.530	55.183	43.668	52.033	46.503
1988	31.328	27.869	28.561	27.644	34.222	36.306	38.093	33.062	31.575	31.492	33.126	30.925	31.334	28.867
1989	30.512	23.610	27.209	37.952	35.698	34.345	34.126	38.482	35.224	30.620	29.490	26.832	27.797	29.006
1990	65.862	55.286	39.885	29.748	21.330	26.062	33.267	37.658	33.654	43.305	58.214	49.758	33.727	28.788
1991	34.205	33.064	29.623	23.706	25.102	27.163	29.040	35.330	35.680	31.675	37.286	37.602	32.249	24.221
1992	51.597	42.052	27.149	21.283	32.230	29.993	28.335	37.048	36.358	33.026	50.903	46.805	23.179	23.577
1993	33.783	28.710	26.450	22.029	27.179	38.882	50.916	42.166	35.083	33.363	34.778	29.094	26.102	33.854
1994	34.103	32.288	33.283	25.413	24.498	31.757	36.816	34.057	31.560	35.447	31.091	31.461	26.935	26.613
1995	31.825	31.420	26.007	23.954	35.369	34.549	34.053	27.639	31.669	33.582	31.222	31.761	25.546	23.417
1996	39.634	34.015	37.849	45.256	23.127	23.687	25.537	26.896	30.740	34.022	38.812	37.347	38.548	37.485
1997	32.488	27.409	37.817	29.013	40.783	28.882	29.258	32.304	38.876	39.417	34.858	36.601	38.723	35.330
1998	45.736	38.828	30.855	22.644	78.966	65.821	42.509	31.305	35.089	33.227	34.649	43.368	33.381	29.818
1999	32.705	26.425	25.888	27.988	39.722	41.627	40.657	31.808	30.976	33.008	35.028	35.954	33.219	34.223
2000	61.846	61.305	56.216	41.012	29.460	30.550	30.395	36.016	42.858	40.572	54.104	66.430	59.269	48.255
2001	38.976	51.159	57.984	51.032	23.497	30.015	38.254	41.826	36.878	36.959	38.933	46.816	48.446	43.503
2002	27.267	29.366	29.111	24.537	31.865	28.107	25.293	30.227	26.432	25.600	26.737	28.436	27.737	25.099
2003	30.670	25.036	31.087	28.698	40.408	37.297	38.067	35.292	28.311	30.103	31.260	26.704	25.504	27.776
2004	34.270	28.072	24.450	28.171	33.236	34.046	32.706	25.678	30.692	31.739	33.793	32.349	32.925	31.519
2005	41.431	31.424	25.928	29.706	38.423	36.446	42.971	41.234	39.466	44.498	48.966	33.710	27.727	32.093
2006	38.623	35.397	32.201	31.225	28.945	29.516	31.656	37.297	36.227	27.879	38.249	35.890	29.457	29.686
2007	30.606	31.648	33.423	32.147	37.139	41.982	42.729	40.651	39.753	39.813	40.396	36.319	35.245	34.670
2008	29.767	29.598	30.838	28.768	42.502	45.198	44.357	31.724	33.807	32.875	40.491	39.387	29.792	29.059
2009	43.705	43.439	34.144	22.252	22.211	24.043	28.403	32.546	31.301	33.428	39.669	39.700	28.166	24.562
2010	41.552	27.486	27.885	26.178	33.754	31.696	28.848	59.602	59.344	47.269	41.850	39.979	29.106	26.594
2011	44.243	42.170	35.222	37.654	51.104	62.286	75.817	64.416	44.530	28.159	61.575	61.138	38.393	32.971
2012	38.253	36.196	35.245	33.672	29.166	31.293	37.918	41.627	37.299	29.581	38.667	38.387	32.761	26.190

....Con't														
Grid No.	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Longitude	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38	38	38	38	38	38	38.5
Latitude	12.5	12	11.5	11	10.5	9.5	8	12	11	10.5	10	9.5	9	11.5
1983	29.170	32.038	34.726	36.713	33.469	30.365	40.356	42.027	34.562	37.238	33.895	25.187	44.559	49.639
1984	30.731	29.982	29.967	30.125	25.314	28.385	26.140	29.885	30.820	30.208	29.085	30.522	27.703	26.880
1985	38.284	35.855	34.239	36.033	37.324	38.237	31.840	35.604	31.563	35.758	36.961	32.292	27.041	36.100
1986	23.201	27.600	37.646	43.037	25.832	26.999	30.039	37.070	29.645	30.663	32.157	32.254	29.625	34.073
1987	21.131	28.960	39.285	56.604	39.017	33.552	45.049	31.989	31.130	42.153	30.600	30.026	39.164	31.231
1988	29.155	30.675	33.576	32.800	33.728	34.356	25.900	30.979	33.762	40.516	38.785	34.910	34.838	40.118
1989	28.064	28.566	28.854	35.995	35.533	27.901	28.973	27.666	29.036	33.963	32.996	31.370	30.244	33.097
1990	21.566	26.775	38.937	38.836	34.594	43.561	23.373	30.380	39.846	36.567	31.100	34.135	29.714	38.336
1991	33.341	30.776	32.525	36.350	37.929	39.471	27.983	56.553	34.552	42.529	49.641	47.192	36.811	46.329
1992	26.386	27.652	25.318	30.844	27.845	34.264	24.822	27.473	31.612	40.644	31.770	33.126	29.214	44.527
1993	30.054	31.121	38.988	30.601	32.625	57.884	34.152	25.146	26.808	30.147	51.435	55.527	34.026	72.598
1994	21.913	28.628	29.119	28.456	31.869	38.114	20.192	22.613	24.292	24.521	38.906	31.881	34.881	38.067
1995	33.623	33.326	27.313	28.578	32.173	32.266	20.617	37.902	27.778	33.929	35.916	27.620	26.877	34.158
1996	24.962	25.157	23.746	30.717	25.323	38.059	31.001	26.056	26.925	27.515	36.106	37.403	32.047	45.243
1997	63.904	36.233	22.058	29.996	38.134	36.932	27.828	55.528	27.847	38.663	42.265	34.248	29.168	77.909
1998	77.448	62.552	39.567	28.732	33.263	29.616	30.161	60.488	28.957	34.263	29.079	26.240	30.021	38.121
1999	25.978	33.625	32.429	28.369	30.959	34.020	20.022	25.224	27.481	30.439	32.907	31.372	24.740	29.898
2000	30.106	27.820	29.779	34.561	39.671	44.269	43.825	28.184	32.177	33.345	28.436	34.646	40.957	41.122
2001	40.471	30.085	43.242	42.296	39.272	35.694	32.857	28.287	50.486	36.914	28.118	29.115	30.026	45.666
2002	62.258	32.376	23.858	26.428	26.916	27.120	21.191	84.130	39.916	30.656	28.540	24.749	23.132	77.057
2003	36.642	33.337	38.068	36.702	28.070	27.288	26.004	29.627	29.359	38.101	31.136	25.197	32.413	33.570
2004	28.242	31.042	33.800	25.880	25.421	48.706	26.665	35.834	35.434	48.329	56.237	52.078	44.407	55.718
2005	42.953	41.944	39.739	38.656	34.534	38.244	35.362	41.468	36.716	52.732	41.217	28.647	27.792	42.189
2006	34.163	34.940	37.201	37.485	33.864	41.748	29.982	43.598	41.544	40.450	33.017	30.468	26.169	57.414
2007	36.997	41.646	41.697	36.028	38.250	50.274	31.728	35.095	32.125	34.436	46.734	52.573	41.961	35.496
2008	34.856	37.981	39.435	31.630	26.874	31.485	28.442	27.194	27.434	26.658	25.141	26.729	25.935	33.188
2009	28.649	27.940	24.693	27.151	27.003	32.401	30.985	31.736	28.461	28.725	28.400	28.283	25.197	35.237
2010	43.334	42.461	37.964	56.898	30.500	34.578	25.169	51.891	46.642	55.007	32.721	25.237	32.597	52.378
2011	31.643	42.043	44.321	49.758	32.825	53.593	27.418	31.489	46.999	36.019	33.128	34.739	29.380	47.218
2012	37.936	37.668	36.463	37.742	34.597	27.696	28.612	36.315	33.104	37.501	37.464	24.471	25.872	62.549

….Con't															
Grid No.	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Longitude	38.5	38.5	38.5	38.5	38.5	39	39	39	39.5	39.5	39.5	39.5	39.5	40	40
Latitude	11	10.5	10	9.5	9	12	11.5	10	11.5	11	10.5	9.5	9	11	9
1983	32.398	37.993	35.246	26.379	61.615	39.144	29.939	24.490	27.950	37.166	45.799	28.418	36.337	19.814	23.912
1984	30.829	28.646	24.442	33.232	30.904	22.272	23.547	22.798	22.923	25.459	33.105	23.446	27.808	33.919	26.824
1985	28.960	32.719	32.250	31.143	29.992	32.945	33.169	25.516	26.829	51.270	45.556	27.604	31.415	27.497	25.640
1986	32.580	29.743	29.977	36.169	34.277	33.359	32.957	25.182	34.502	32.974	33.780	27.310	34.907	30.686	22.660
1987	22.556	26.635	27.580	31.653	32.468	22.718	26.021	27.104	25.225	28.242	28.222	23.663	40.300	22.118	36.832
1988	35.876	40.704	40.617	34.383	33.461	40.063	39.969	33.660	45.556	38.553	31.431	28.135	26.324	32.821	24.975
1989	25.054	32.354	34.447	34.431	41.160	21.640	21.772	29.509	24.530	35.732	49.683	34.297	54.835	25.869	28.140
1990	36.188	34.237	28.967	33.166	28.880	25.056	31.711	25.082	25.464	27.311	29.794	20.773	28.707	33.543	33.591
1991	32.462	41.199	39.290	34.725	36.784	30.925	49.055	27.738	31.142	38.350	66.729	32.028	31.296	22.927	28.447
1992	47.911	70.799	48.787	39.153	37.895	31.323	42.319	31.781	39.892	58.769	61.800	30.235	30.443	30.834	35.436
1993	44.612	63.523	38.338	51.248	36.251	77.623	90.724	28.497	109.280	119.947	121.159	23.208	39.282	121.805	61.212
1994	26.834	31.166	32.841	36.102	35.616	28.222	45.927	27.584	53.605	64.226	59.609	33.724	36.293	34.917	32.923
1995	32.248	35.764	46.601	41.565	54.914	35.456	32.945	24.976	33.683	34.276	32.918	25.320	30.528	30.250	30.269
1996	29.375	41.071	35.848	34.526	34.640	37.861	46.988	30.013	45.743	40.104	41.586	23.969	30.252	31.840	30.358
1997	56.533	48.817	37.280	33.843	29.785	35.533	42.047	27.075	40.505	53.175	47.909	26.189	27.465	24.930	20.731
1998	32.938	33.000	29.617	31.065	37.268	45.528	33.907	29.433	36.172	36.100	31.690	26.863	29.826	31.415	26.444
1999	29.166	32.032	32.254	30.136	31.926	27.903	29.069	26.239	31.422	32.618	27.745	21.050	21.058	28.058	16.684
2000	33.918	39.307	29.710	29.892	35.860	35.513	31.074	28.295	32.955	26.236	52.267	24.292	44.343	29.147	58.344
2001	57.579	62.241	28.535	28.320	32.010	25.160	32.995	23.472	61.490	31.921	54.640	21.934	25.959	37.201	26.042
2002	51.833	61.174	41.233	34.140	30.297	107.333	137.037	32.382	161.961	149.615	65.998	28.177	22.949	176.076	19.078
2003	28.077	45.645	43.395	39.592	55.463	25.497	33.934	28.773	35.750	44.785	41.398	30.923	29.574	37.207	20.083
2004	36.213	43.840	44.591	37.337	35.631	38.011	41.564	24.565	43.592	46.975	42.923	24.183	29.467	38.317	23.795
2005	35.776	51.046	44.354	36.371	37.318	31.438	40.644	34.534	51.789	42.788	45.648	25.426	29.264	35.096	17.879
2006	39.575	41.245	36.372	32.999	30.425	40.503	45.753	30.202	37.194	40.142	32.012	24.646	25.166	31.582	23.960
2007	29.365	30.774	41.798	53.870	44.826	32.099	31.613	33.714	30.604	29.133	26.544	35.776	33.762	24.706	21.810
2008	26.456	32.312	30.846	30.365	31.598	31.592	30.686	27.032	31.144	28.900	31.778	24.962	22.669	31.215	17.404
2009	28.258	27.930	32.608	30.115	32.951	29.938	24.838	27.513	24.858	33.114	42.812	22.243	22.749	32.356	25.806
2010	38.072	32.904	29.655	30.677	27.213	36.710	41.783	20.782	32.563	30.993	28.648	26.752	35.270	20.939	18.878
2011	35.723	40.892	33.808	30.311	30.098	27.810	31.770	25.018	26.534	27.899	33.203	23.153	26.661	25.913	23.482
2012	34.649	43.840	35.826	24.019	43.526	26.041	32.074	27.437	29.171	29.508	43.177	34.775	44.981	23.702	47.482

ECMWF- with bias corrected 2-day for 0.5 by 0.5 grid Size, year 1983-2012														
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Longitude	34.5	34.5	35	35.5	35.5	35.5	36	36	36	36	36	36.5	36.5	36.5
Latitude	10	9.5	10	9.5	9	8	10.5	9.5	9	8.5	8	11.5	11	10
1983	61.562	48.099	62.092	65.34	45.649	34.237	42.709	47.656	44.851	48.439	44.52	43.3	39.128	47.886
1984	46.756	36.718	42.143	54.559	34.466	30.814	37.41	63.114	55.959	35.27	38.111	47.523	35.773	51.818
1985	29.446	23.623	37.9	31.43	32.249	35.791	59.908	37.692	34.363	33.285	36.675	35.825	37.85	45.146
1986	51.757	53.485	48.694	53.591	49.252	36.747	38.766	49.859	48.02	41.304	39.827	46.525	39.418	44.16
1987	45.128	48.531	49.401	56.45	55.853	61.386	39.435	55.61	58.6	59.644	59.172	39.381	35.506	49.553
1988	35.685	46.58	43.142	43.67	39.724	39.977	46.992	42.68	39.003	37.669	42.414	45.78	44.43	46.433
1989	43.726	45.505	54.899	50.967	43.885	64.776	55.804	45.412	42.68	49.078	55.621	55.549	48.343	51.536
1990	48.386	52.887	60.219	81.252	71.316	55.493	47.284	83.466	81.57	67.079	56.942	41.987	48.132	63.857
1991	38.693	43.987	42.14	56.339	57.408	52.341	45.706	50.726	56.437	54.559	49.375	49.376	44.885	43.762
1992	32.714	37.523	37.419	51.42	41.506	34.368	45.234	63.232	57.037	44.161	33.948	38.662	38.551	58.621
1993	44.59	39.287	39.918	40.296	33.072	33.072	44.375	45.728	42.996	34.17	35.345	65.766	53.854	46.056
1994	32.137	28.18	38.469	43.266	34.577	46.289	43.134	40.453	48.665	39.541	44.399	50.755	41.537	37.25
1995	36.481	36.754	37.843	43.013	44.952	40.526	43.522	44.746	50.931	46.991	40.895	43.479	39.529	43.594
1996	48.281	50.691	55.123	54.118	52.58	59.427	52.649	53.463	52.766	49.172	57.619	43.57	44.576	48.402
1997	47.922	40.735	67.322	58.575	42.853	37.128	42.615	35.76	40.915	43.978	40.1	39.504	42.037	39.867
1998	49.626	38.164	49.784	48.605	49.77	38.656	52.305	55.314	53.629	48.977	41.376	50.063	46.895	48.722
1999	37.103	53.818	41.579	42.1	39.99	41.161	39.687	42.855	43.001	36.231	33.78	43.54	37.495	43.51
2000	51.937	52.855	49.098	63.178	60.813	53.505	54.073	70.989	72.124	67.443	56.267	54.396	52.919	52.727
2001	70.898	62.451	62.453	64.844	62.5	54.384	44.132	55.741	61.01	61.812	53.864	39.236	39.023	48.45
2002	33.251	35.448	38.147	33.444	31.903	38.871	41.014	38.27	37.109	29.808	33.595	42.028	42.613	45.189
2003	40.647	34.331	45.476	49.124	43.547	36.984	45.24	40.877	39.98	35.413	38.794	52.936	41.909	37.926
2004	32.955	27.507	34.093	48.31	40.234	24.868	40.976	40.103	39.351	32.267	28.413	38.215	39.327	45.78
2005	42.061	44.949	49.052	57.226	48.85	60.692	53.703	63.57	57.714	52.235	58.106	54.918	48.832	66.888
2006	50.838	49.449	53.061	43.121	47.942	44.137	44.87	51.241	51.509	47.179	41.33	39.678	45.138	42.749
2007	32.294	33.622	41.234	65.924	61.356	62.552	47.335	55.195	59.194	49.732	38.002	52.384	50.402	43.949
2008	45.102	58.321	44.176	43.11	46.629	43.459	46.929	39.717	44.461	41.683	38.893	57.032	43.748	43.001
2009	41.344	33.893	50.096	41.803	44.792	51.881	50.302	46.854	53.429	39.639	42.602	44.99	44.786	39.906
2010	48.724	49.139	54.135	49.755	42.896	64.979	86.79	53.999	45.163	51.287	53.18	49.293	71.688	65.546
2011	126.03	129.21	116.21	113.82	83.359	50.494	59.759	70.499	56.761	43.675	48.306	78.89	57.612	42.704
2012	36.536	38.291	40.281	65.772	76.596	62.097	54.893	57.705	79.565	74.008	68.241	61.36	59.371	52.793

....Con't														
Grid No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Longitude	36.5	36.5	36.5	36.5	37	37	37	37	37	37	37	37	37	37
Latitude	9.5	9	8.5	8	12.5	12	11.5	11	10.5	10	9.5	9	8.5	8
1983	45.516	43.384	50.974	44.249	36.551	41.636	47.126	38.814	47.205	49.813	45.77	46.926	48.844	37.878
1984	61.4	42.644	39.646	38.994	42.405	44.251	48.212	37.005	38.025	37.886	47.1	55.618	41.837	38.502
1985	41.138	29.676	31.09	37.033	44.957	38.565	41.969	42.644	44.545	43.335	40.572	37.801	33.781	40.577
1986	45.93	41.23	41.142	41.981	32.346	40.706	43.962	47.223	39.288	45.742	49.386	50.103	43.453	40.323
1987	60.976	50.973	54.427	53.914	38.222	36.537	63.19	64.992	46.005	47.861	61.565	49.074	54.461	54.895
1988	43.536	36.76	35.138	39.501	42.39	44.081	45.742	49.472	50.59	47.196	46.145	41.549	40.485	37.95
1989	39.86	36.276	33.21	46.334	38.614	40.829	53.163	55.458	55.095	48.1	37.519	40.402	38.915	45.01
1990	79.042	68.992	54.987	44.076	31.325	33.322	43.603	53.646	48.329	55.469	71.158	62.662	47.356	42.809
1991	46.803	46.3	51.817	46.117	48.897	44.055	45.192	45.539	44.088	40.97	52.206	51.97	45.385	45.729
1992	67.318	58.73	48.032	36.503	44.619	40.655	38.96	45.137	45.971	49.726	61.688	56.524	42.937	39.583
1993	48.334	42.381	37.251	34.718	42.604	55.403	68.219	61.257	50.218	43.971	51.717	47.588	36.908	45.065
1994	44.159	43.471	40.091	38.932	32.175	43.515	56.024	50.741	42.55	45.038	45.524	51.408	38.769	33.703
1995	44.31	48.026	47.154	41.561	50.987	44.444	40.485	39.576	41.354	36.838	40.853	47.281	45.481	41.153
1996	50.417	54.404	54.521	50.859	35.745	38.836	36.175	46.074	51.32	52.202	63.406	71.872	65.923	56.622
1997	38.03	41.305	56.402	45.684	44.172	41.5	38.92	44.925	48.92	43.724	41.252	58.471	66.155	52.145
1998	59.248	56.16	51.602	41.865	93.6	80.124	54.592	44.759	50.101	47.174	58.796	56.741	50.181	44.921
1999	44.853	42.837	42.812	46.233	55.388	48.872	46.351	40.469	45.614	47.605	49.41	57.16	53.852	55.461
2000	71.469	72.99	70.625	59.083	42.782	48.138	52.87	52.185	49.762	44.917	60.955	79.549	74.572	65.792
2001	52.719	54.099	60.119	54.101	36.433	40.333	44.369	45.598	40.946	47.203	57.114	54.195	51.285	47.194
2002	40.021	36.646	31.745	33.784	42.842	39.928	37.473	52.292	50.425	43.226	35.054	35.658	32.565	37.208
2003	37.01	36.302	36.966	38.512	49.159	48.726	53.049	45.501	38.825	39.613	43.892	45.378	35.188	34.571
2004	44.968	38.208	33.792	32.177	41.692	43.36	44.171	39.907	45.966	47.183	48.997	46.626	36.633	35.79
2005	68.057	54.285	49.051	55.595	52.083	49.214	56.474	52.352	59.326	66.865	72.333	54.55	46.624	50.2
2006	54.877	51.162	48.559	44.286	37.353	35.362	37.658	46.605	42.959	40.417	55.165	52.849	45.872	42.74
2007	42.422	44.375	48.186	37.697	48.602	52.942	53.65	51.618	48.381	48.51	51.054	43.803	39.289	37.752
2008	38.444	36.711	38.169	38.245	57.93	56.952	50.458	45.984	40.517	38.992	42.729	40.891	38.398	38.449
2009	51.448	44.98	37.596	37.297	41.387	44.791	44.909	43.326	45.094	44.358	50.28	42.559	36.678	36.151
2010	50.155	42.031	46.238	42.801	38.726	35.927	33.609	62.334	63.546	52.659	48.545	50.553	41.719	41.566
2011	48.558	48.474	40.077	43.892	53.488	64.41	78.535	66.217	45.759	38.696	70.036	71.957	49.121	42.13
2012	45.714	48.109	59.887	59.423	49.423	57.838	63.526	64.063	61.116	52.744	48.636	48.522	40.877	38.064

….Con't														
Grid No.	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Longitude	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38	38	38	38	38	38	38.5
Latitude	12.5	12	11.5	11	10.5	9.5	8	12	11	10.5	10	9.5	9	11.5
1983	39.156	45.631	51.666	44.081	40.278	40.59	49.387	54.503	43.921	42.456	40.996	32.649	55.298	63.965
1984	45.219	43.281	42.038	42.246	38.054	48.447	35.491	43.373	44.76	40.955	49.133	46.162	41.43	42.697
1985	41.415	41.867	42.094	46.881	49.547	51.127	42.238	39.876	45.539	50.924	53.029	45.414	37.19	46.631
1986	33.899	37.441	49.111	53.888	43.234	50.892	35.673	54.909	43.988	46.714	48.883	46.16	40.434	55.565
1987	37.251	40.493	50.608	69.117	46.64	39.736	55.256	50.842	42.253	54.813	35.817	39.202	47.366	55.59
1988	43.324	46.552	47.805	53.773	52.79	50.945	34.554	49.934	56.471	56.413	52.087	51.405	49.772	61.23
1989	37.41	38.968	50.176	57.4	54.694	41.645	51.129	41.376	53.245	56.511	53.454	39.478	41.471	41.275
1990	32.788	35.626	48.527	50.902	46.296	54.414	36.707	37.672	47.917	47.888	41.142	40.424	35.147	47.666
1991	45.637	44.027	49.672	53.231	47.852	64.499	37.915	59.779	56.396	78.503	69.349	76.279	70.708	74.856
1992	43.776	45.06	47.033	47.491	44.177	46.34	39.46	52.907	47.695	50.783	42.637	45.822	41.379	61.439
1993	45.859	47.157	58.632	51.459	46.329	65.878	44.99	39.763	42.546	53.605	62.842	66.524	41.374	84.273
1994	30.151	42.226	49.61	49.12	44.23	50.347	31.925	37.001	47.465	44.749	52.681	44.239	41.175	47.61
1995	45.975	46.755	38.438	40.673	43.048	40.864	33.672	50.536	43.248	46.44	39.722	37.655	38.375	52.282
1996	34.562	38.527	37.365	45.431	44.017	60.756	52.699	37.601	39.521	44.595	51.064	51.95	60.758	68.153
1997	68.479	42.691	30.299	42.021	47.432	42.385	41.022	71.054	38.118	44.704	48.887	41.539	37.2	83.139
1998	93.228	77.12	52.701	49.066	57.798	48.637	45.119	77.825	46.322	65.701	49.572	42.548	44.179	57.897
1999	43.978	41.348	39.09	42.155	45.531	52.328	35.759	47.279	45.568	50.476	49.917	51.221	45.262	44.958
2000	43.339	50.93	51.353	50.035	48.204	49.066	62.316	49.085	47.169	54.933	40.106	39.176	50.991	56.382
2001	70.628	42.254	50.97	48.649	43.617	53.105	41.421	49.621	53.878	41.955	40.653	44.931	45.979	48.097
2002	64.852	44.536	42.343	42.235	43.851	33.291	36.943	102.61	42.242	37.267	33.788	31.762	31.634	118.76
2003	50.765	44.45	51.506	50.16	37.961	42.904	30.992	43.361	42.937	46.315	39.281	41.902	37.137	59.809
2004	38.229	41.681	49.347	44.862	49.196	69.623	35.788	58.21	62.513	78.849	76.696	69.043	61.084	70.889
2005	57.932	56.247	51.777	51.489	53.841	60.869	48.827	58.502	49.146	64.632	51.577	47.203	48.927	51.258
2006	42.864	37.738	48.493	51.018	47.377	55.807	38.092	43.598	52.304	50.097	44.496	42.272	38.525	66.584
2007	52.877	55.856	53.061	52.19	47.696	62.259	37.133	59.412	49.085	53.299	58.869	65.708	55.459	57.954
2008	48.068	50.383	48.851	44.885	38.742	45.373	36.136	48.058	42.974	43.017	40.427	37.967	39.568	51.842
2009	38.807	43.666	42.124	41.546	43.285	49.148	50.262	42.638	39.62	43.191	42.255	45.099	37.19	47.25
2010	52.579	51.823	47.441	56.898	40.747	35.37	47.384	67.456	47.675	55.007	39.018	33.11	32.597	72.401
2011	40.117	45.626	45.984	52.216	51.386	63.637	47.234	45.148	46.999	53.748	41.316	42.198	46.969	64.973
2012	47.155	61.275	63.212	61.309	58.108	41.375	44.937	52.254	55.154	46.34	44.435	42.624	41.938	62.549

....Con't															
Grid No.	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Longitude	38.5	38.5	38.5	38.5	38.5	39	39	39	39.5	39.5	39.5	39.5	39.5	40	40
Latitude	11	10.5	10	9.5	9	12	11.5	10	11.5	11	10.5	9.5	9	11	9
1983	46.4	44.001	39.849	41.596	68.117	59.311	47.694	34.314	41.386	40.105	50.333	42.73	38.87	29.633	34.617
1984	42.827	37.299	43.411	48.793	39.683	38.838	37.914	33.316	34.726	39.815	45.075	41.867	47.847	38.568	44.502
1985	46.933	48.857	42.991	44.055	40.935	37.568	41.531	35.621	40.162	63.575	54.582	34.139	39.816	42.655	38.95
1986	52.746	44.387	42.028	53.511	53.123	54.231	59.794	40.171	59.632	61.191	59.396	44.384	51.518	45.311	32.288
1987	41.684	49.457	38.794	45.45	41.632	40.017	48.186	35.166	45.222	52.296	51.218	41.5	64.553	35.897	61.269
1988	60.669	61.882	55.992	49.092	45.422	53.455	56.81	50.093	66.38	60.702	55.496	43.91	39.368	54.357	31.631
1989	42.765	49.585	43.272	40.242	49.654	33.173	32.323	35.214	33.682	41.564	54.898	39.621	62.365	34.775	38.695
1990	47.59	43.032	36.064	38.98	38.01	34.399	40.457	30.837	36.903	47.651	53.589	32.907	37.941	57.171	44.168
1991	46.493	62.384	66.789	53.822	51.892	38.272	59.425	53.19	45.567	66.777	83.602	60.885	58.724	28.989	53.107
1992	58.413	76.758	51.147	55.168	54.084	45.564	49.76	37.308	52.329	69.951	66.236	43.823	42.53	38.234	42.337
1993	52.64	75.71	64.449	68.178	49.865	90.624	101.69	52.364	120.51	130.17	141.7	41.379	53.67	133.89	100.22
1994	46.157	50.027	45.104	51.126	49.814	36.615	45.927	38.997	53.605	64.226	59.609	45.357	59.807	52.957	58.596
1995	49.567	46.793	42.988	41.565	54.914	48.819	48.888	32.524	47.869	48.172	50.849	36.226	35.873	48.089	40.565
1996	46.091	53.908	49.909	45.49	50.726	57.454	66.697	44.194	75.306	60.916	66.71	39.121	47.001	42.858	55.42
1997	57.568	56.957	47.339	49.575	43.139	47.745	57.115	37.726	45.591	58.805	54.163	41.142	40.008	39.85	35.109
1998	53.515	57.359	45.301	41.002	45.275	73.088	57.349	40.443	59.142	62.457	53.298	42.769	47.68	54.563	37.178
1999	43.65	47.092	48.153	51.201	51.697	48.119	44.005	44.299	43.189	43.452	44.093	38.285	36.441	43.227	27.542
2000	44.387	58.132	41.501	37.553	43.511	63.398	42.714	38.523	47.042	41.181	68.967	40.723	56.42	49.102	66.008
2001	57.579	62.241	42.097	40.19	45.21	44.705	47.073	35.623	61.49	54.53	54.64	37.486	40.36	49.177	30.374
2002	51.833	61.174	41.233	38.317	35.672	155.74	174.03	32.382	214.91	185.17	77.215	30.37	33.729	219.83	33.108
2003	46.609	63.899	48.845	40.384	57.696	44.039	58.82	52.237	69.004	86.384	82.726	41.953	35.794	58.083	27.647
2004	42.414	66.654	66.528	53.109	53.387	46.034	55.695	43.064	48.398	51.947	64.113	39.366	47.872	42.892	30.543
2005	49.042	52.874	46.527	48.758	47.895	45.687	54.111	41.859	59.524	62.749	56.751	45.938	40.179	58.411	26.983
2006	50.889	52.495	47.803	40.642	37.968	49.617	55.47	43.822	59.423	61.619	51.753	33.714	33.802	51.264	35.412
2007	47.272	54.006	60.988	69.957	61.823	61.043	53.627	51.049	41.225	41.555	43.407	56.715	52.872	36.699	36.481
2008	43.535	40.403	40.338	37.266	41.266	54.065	53.959	38.717	58.975	54.922	59.041	45.819	39.025	54.991	31.539
2009	44.481	42.938	41.207	41.602	48.751	42.761	40.676	36.608	44.858	55.509	52.743	39.199	38.163	58.933	30.653
2010	53.817	44.84	36.954	32.989	39.173	56.693	64.921	29.804	55.164	53.142	42.126	29.98	45.107	39.149	29.917
2011	43.916	52.269	41.041	41.236	45.366	43.056	41.621	37.872	43.611	49.428	45.896	38.965	48.857	51.333	42.592
2012	46.671	47.414	43.932	43.154	43.526	39.951	42.061	37.307	44.244	45.521	73.038	56.381	64.87	39.26	59.76

ECMWF- with bias corrected 3-day for 0.5 by 0.5 grid Size, year 1983-2012														
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Longitude	34.5	34.5	35	35.5	35.5	35.5	36	36	36	36	36	36.5	36.5	36.5
Latitude	10	9.5	10	9.5	9	8	10.5	9.5	9	8.5	8	11.5	11	10
1983	63.840	51.181	66.157	72.771	53.293	40.762	52.257	63.474	61.268	55.466	47.816	52.449	49.389	56.186
1984	46.756	36.718	45.285	58.074	41.647	43.155	52.665	66.820	61.191	42.358	46.601	61.406	45.737	54.705
1985	32.034	26.743	41.061	36.689	36.258	41.809	63.006	41.550	39.053	38.800	43.145	54.155	51.287	48.739
1986	66.989	61.060	68.185	58.438	52.214	42.960	49.033	52.190	48.696	43.861	43.425	54.721	49.558	42.503
1987	55.179	60.792	54.343	61.355	53.544	51.272	48.528	52.443	51.344	50.408	50.693	43.376	40.628	59.034
1988	43.575	50.593	50.156	51.061	49.039	48.421	54.189	51.146	50.037	50.904	49.577	51.403	52.214	54.985
1989	48.897	53.424	59.064	56.205	51.989	70.436	65.832	56.024	49.496	52.520	60.227	65.871	67.810	56.261
1990	54.114	57.487	60.272	77.637	67.191	58.499	71.356	80.514	77.510	60.278	61.497	60.914	67.941	68.212
1991	38.693	43.987	43.725	65.184	61.624	54.047	60.353	65.601	67.920	61.572	52.902	81.282	62.270	59.572
1992	39.652	45.128	43.023	60.581	56.648	51.648	60.696	68.735	68.985	59.890	49.320	58.618	62.595	53.582
1993	44.976	49.262	40.292	47.587	42.396	43.569	49.494	50.617	47.277	45.172	49.189	69.535	58.384	49.586
1994	43.417	37.831	48.025	53.678	42.396	56.581	50.383	55.249	50.849	49.677	53.514	60.651	47.378	48.134
1995	45.712	44.221	58.881	50.966	52.609	49.337	50.810	51.549	58.604	54.237	48.309	45.402	42.122	56.914
1996	46.253	59.942	62.345	50.955	59.297	69.818	53.225	56.081	55.840	56.152	65.248	48.414	54.800	62.322
1997	52.267	45.387	75.870	75.935	55.393	45.677	49.300	54.883	56.825	49.324	45.145	38.658	43.836	51.954
1998	64.353	45.623	66.251	60.859	53.001	53.273	65.487	62.073	61.172	56.862	54.760	62.276	62.854	54.519
1999	43.669	39.730	47.890	46.968	46.146	49.033	50.733	46.804	48.363	42.483	41.689	47.633	43.700	45.947
2000	62.345	66.944	64.054	68.903	66.118	62.084	76.446	76.577	78.408	72.474	63.004	73.079	75.229	68.682
2001	71.708	62.451	62.714	64.948	82.349	59.991	54.069	62.664	67.171	64.513	61.598	60.995	60.142	58.037
2002	38.254	39.285	40.967	40.261	42.075	44.338	46.028	43.773	45.135	42.924	41.199	54.477	46.761	48.196
2003	43.042	37.103	50.399	53.672	47.946	51.295	52.337	47.373	49.227	50.416	52.288	61.587	50.671	47.114
2004	35.400	29.353	38.308	45.345	39.994	33.787	47.586	42.445	43.488	39.247	37.176	43.002	43.231	46.273
2005	50.456	51.018	57.413	55.142	58.182	70.680	62.872	55.063	54.747	62.121	69.832	62.918	63.504	60.565
2006	45.603	48.401	56.247	54.722	56.393	53.287	54.707	67.519	69.663	68.322	61.575	54.384	55.016	57.040
2007	46.948	42.076	51.272	71.033	67.726	78.344	55.638	63.440	67.898	56.178	46.276	62.247	64.936	54.658
2008	55.566	67.236	60.854	62.681	50.909	46.843	67.895	53.016	55.112	49.741	39.459	62.898	63.563	54.256
2009	52.162	57.768	58.050	53.346	55.622	60.889	54.356	58.134	65.086	51.191	53.970	59.921	63.502	50.081
2010	60.841	71.228	64.700	69.467	66.735	80.726	111.530	73.135	61.887	62.863	69.331	66.609	91.664	89.649
2011	120.363	124.325	110.395	111.613	77.341	66.461	64.166	76.208	61.510	60.700	65.403	85.363	67.769	55.503
2012	46.225	46.203	50.567	73.481	81.750	67.977	63.847	64.532	85.085	78.459	73.729	69.413	69.793	58.618

....Con't														
Grid No.	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Longitude	36.5	36.5	36.5	36.5	37	37	37	37	37	37	37	37	37	37
Latitude	9.5	9	8.5	8	12.5	12	11.5	11	10.5	10	9.5	9	8.5	8
1983	64.010	61.363	58.389	48.158	46.852	45.366	51.732	50.399	58.246	61.946	61.009	58.800	57.551	45.666
1984	65.839	47.666	44.073	45.299	58.215	56.440	68.057	52.010	45.727	42.096	52.910	53.985	48.679	44.982
1985	44.139	43.395	45.611	42.592	53.354	49.109	64.543	62.624	57.308	47.668	45.667	53.333	47.176	44.678
1986	46.412	47.626	50.223	50.028	46.663	52.987	53.783	52.220	48.735	43.573	54.085	54.121	49.573	51.537
1987	64.196	47.055	46.988	45.556	33.954	38.340	64.204	69.468	68.679	64.268	69.444	55.348	60.017	59.807
1988	51.904	48.050	48.455	49.601	46.380	47.711	53.573	59.542	61.472	57.226	60.681	55.959	49.234	48.723
1989	54.468	47.004	43.244	46.958	53.353	54.429	64.670	67.836	63.263	51.972	46.265	45.924	52.048	55.665
1990	79.281	67.340	52.574	52.462	37.974	52.305	62.349	70.434	66.351	64.450	75.163	64.326	54.044	52.102
1991	60.381	59.878	60.570	51.083	57.934	59.946	61.907	61.024	62.568	58.341	57.695	56.350	54.177	50.041
1992	73.427	66.817	53.674	53.707	50.896	45.545	61.840	66.618	61.819	54.705	75.018	79.479	55.092	57.222
1993	52.629	47.448	47.360	48.040	46.971	58.497	73.439	66.470	57.172	52.687	60.926	52.262	47.409	50.402
1994	52.568	50.326	49.115	46.358	46.820	53.744	57.955	51.352	51.301	55.366	53.071	52.984	46.425	49.745
1995	50.395	53.547	52.455	47.311	52.896	54.238	58.258	51.942	50.149	54.368	57.722	52.816	50.603	46.410
1996	60.297	63.201	63.522	59.217	42.929	46.625	55.316	58.072	63.260	67.244	73.577	78.956	71.765	62.653
1997	48.816	48.367	57.913	47.775	60.047	53.753	41.183	53.038	57.529	56.699	51.875	62.057	69.002	61.795
1998	64.698	60.589	58.591	59.715	108.611	93.599	64.673	61.833	58.119	52.634	63.956	60.771	63.755	69.920
1999	48.407	38.952	37.380	40.397	63.715	52.853	53.493	55.779	50.603	50.495	53.518	48.636	44.469	44.072
2000	83.090	79.647	74.605	64.746	52.728	55.360	65.118	72.353	71.710	65.597	79.169	90.001	80.545	70.658
2001	62.667	62.638	64.218	76.167	52.266	57.794	64.675	66.816	60.606	54.818	67.300	67.373	62.735	57.915
2002	46.669	44.933	40.901	47.474	64.984	60.009	53.093	61.690	56.602	47.796	48.100	46.753	44.935	50.891
2003	45.001	47.315	46.693	48.963	73.228	71.254	68.230	57.783	57.057	49.241	56.403	57.279	45.492	41.740
2004	46.105	42.250	42.596	41.888	49.581	49.944	50.743	45.770	46.160	47.183	50.165	51.037	47.063	45.352
2005	57.499	47.063	55.573	65.462	59.987	55.925	64.208	77.828	71.996	62.449	70.700	51.953	51.865	56.075
2006	73.069	73.555	73.230	69.404	50.659	55.110	62.755	54.510	49.904	52.615	75.685	80.326	74.097	72.425
2007	56.401	55.517	56.712	44.411	53.714	58.385	67.650	68.671	59.838	56.411	59.549	57.471	51.546	48.318
2008	49.590	44.012	48.123	45.209	64.798	69.529	69.916	62.976	55.514	48.305	51.351	49.242	47.346	47.355
2009	60.076	59.212	46.309	42.900	52.736	53.974	62.221	70.665	61.509	52.714	65.707	65.631	48.358	46.076
2010	68.850	59.337	53.294	55.789	59.296	52.201	51.088	87.831	88.164	73.880	57.470	59.997	54.638	54.542
2011	60.801	54.663	52.094	58.111	56.111	67.289	82.480	71.269	62.836	52.667	77.461	74.760	56.448	54.347
2012	59.312	52.520	63.226	64.075	66.281	69.317	74.157	79.115	72.911	59.792	62.242	54.699	47.331	48.590

….Con't														
Grid No.	29	30	31	32	33	34	35	36	37	38	39	40	41	42
Longitude	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38	38	38	38	38	38	38.5
Latitude	12.5	12	11.5	11	10.5	9.5	8	12	11	10.5	10	9.5	9	11.5
1983	45.389	47.353	55.159	58.580	52.662	55.901	48.591	56.385	56.566	48.741	49.600	50.921	66.259	67.241
1984	50.221	53.567	66.147	56.391	49.006	50.021	44.879	59.601	55.506	53.694	54.503	52.270	49.599	62.578
1985	56.443	56.107	67.134	68.429	64.510	57.206	44.697	55.822	69.279	76.013	69.018	56.178	54.131	59.547
1986	50.465	56.756	68.401	70.188	45.598	63.718	46.795	64.307	65.142	53.222	50.176	60.741	55.532	89.638
1987	45.419	46.274	51.651	73.947	68.535	52.287	60.273	64.878	51.311	58.648	41.556	48.709	60.290	83.432
1988	54.122	52.729	56.218	62.283	63.923	62.892	43.749	59.015	66.532	66.789	62.814	63.612	59.805	69.864
1989	54.148	54.982	63.396	61.880	58.073	53.421	62.551	55.891	57.261	65.011	75.191	54.950	60.567	47.173
1990	43.766	57.395	70.555	69.844	63.288	63.941	45.985	60.025	69.605	63.955	56.221	55.816	48.680	66.122
1991	49.810	55.870	64.094	62.786	62.213	81.290	45.847	62.793	63.748	91.936	86.217	91.325	82.009	74.856
1992	49.808	51.092	60.448	63.365	58.700	55.024	50.733	66.363	60.469	70.181	57.254	53.156	49.987	70.477
1993	47.113	49.415	61.580	60.761	51.358	78.200	50.163	49.091	61.324	70.821	76.889	79.663	58.283	84.273
1994	42.821	47.971	45.834	45.239	54.788	60.343	45.993	46.696	47.407	53.072	63.720	56.152	55.698	53.186
1995	46.848	49.409	54.411	60.447	57.433	60.935	44.500	59.504	60.802	56.576	50.673	48.283	53.421	69.056
1996	48.428	51.879	54.007	54.754	57.288	68.552	57.793	45.871	62.167	61.436	60.595	57.640	65.083	71.275
1997	86.013	63.947	38.858	47.660	57.523	62.841	55.825	84.695	45.895	64.010	69.204	63.681	56.080	83.139
1998	107.198	89.100	60.815	55.570	53.474	52.965	70.384	88.185	60.422	49.775	48.076	48.319	55.154	77.818
1999	65.556	60.284	56.896	59.205	54.332	56.590	37.559	63.764	54.890	55.719	54.771	56.162	51.677	63.477
2000	61.828	62.895	64.170	65.380	63.607	69.082	68.668	60.569	58.508	57.951	53.524	56.527	63.364	66.502
2001	71.668	63.946	67.336	64.221	61.057	62.085	55.624	70.294	70.618	59.773	50.888	52.247	59.554	80.041
2002	65.736	61.997	60.552	54.253	52.695	43.594	50.317	111.511	55.735	51.583	44.677	41.732	36.873	157.202
2003	67.520	65.563	60.467	64.387	60.976	50.688	41.921	59.404	59.552	61.394	50.032	48.719	44.380	60.352
2004	48.524	50.511	56.538	53.274	48.587	60.786	46.404	56.273	70.301	83.312	77.121	61.761	57.409	66.114
2005	60.696	54.499	59.215	73.012	71.185	61.975	58.850	57.956	61.151	83.445	63.554	51.347	45.874	63.178
2006	52.859	55.007	61.608	66.718	56.444	68.850	68.075	56.753	72.122	64.238	55.205	60.520	64.452	78.434
2007	59.419	60.873	62.045	64.053	64.631	73.614	46.756	68.088	61.503	74.659	80.380	78.575	70.496	67.536
2008	59.575	64.306	69.830	64.006	57.366	55.038	50.867	54.767	58.299	55.692	54.786	56.936	52.449	59.215
2009	58.475	56.777	55.418	60.290	59.592	58.784	63.477	63.099	57.857	61.323	55.895	55.129	51.406	70.048
2010	61.310	57.741	54.065	64.211	53.821	47.407	56.981	75.331	54.273	59.370	44.543	40.345	47.230	81.103
2011	52.670	60.003	58.783	62.973	68.476	68.633	58.656	60.270	59.489	68.376	55.644	46.148	50.732	73.354
2012	47.155	64.537	80.855	79.718	72.910	57.290	50.708	67.332	74.934	60.125	49.866	46.690	47.195	73.514

….Con't															
Grid No.	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Longitude	38.5	38.5	38.5	38.5	38.5	39	39	39	39.5	39.5	39.5	39.5	39.5	40	40
Latitude	11	10.5	10	9.5	9	12	11.5	10	11.5	11	10.5	9.5	9	11	9
1983	62.551	60.327	53.476	58.610	93.905	69.552	55.581	48.947	44.783	50.092	56.557	54.807	46.964	36.317	43.648
1984	48.858	54.170	50.153	57.287	51.445	54.973	50.536	41.862	43.908	47.388	53.315	49.586	60.837	42.749	53.855
1985	69.387	75.153	66.507	52.455	52.462	45.767	59.546	51.959	61.038	65.988	63.246	44.754	50.652	64.735	48.013
1986	85.326	70.345	57.306	53.703	50.514	77.498	88.754	55.572	83.920	91.806	84.333	66.107	60.740	52.971	49.676
1987	62.778	57.823	44.329	60.509	61.767	45.412	45.787	44.680	59.343	70.071	73.688	54.311	73.579	53.686	74.166
1988	69.947	71.552	65.586	59.534	56.096	74.961	81.477	59.774	99.466	92.368	71.610	60.353	55.570	81.081	40.432
1989	49.814	70.903	65.050	57.791	60.038	37.597	46.890	58.171	48.563	60.312	86.870	56.295	67.496	52.971	57.726
1990	63.279	60.246	60.897	63.006	51.459	49.256	55.846	53.928	51.898	56.524	66.186	46.053	63.984	69.262	62.787
1991	57.378	62.384	79.545	74.678	55.596	43.457	82.557	66.522	47.521	69.804	101.258	72.758	72.892	35.978	68.374
1992	63.201	87.636	61.737	65.841	69.543	56.458	61.553	49.672	57.551	58.769	61.800	54.717	57.242	52.071	70.851
1993	71.117	90.740	81.184	84.520	66.899	90.624	101.685	66.365	122.574	131.161	141.698	56.982	70.484	133.888	137.893
1994	56.171	62.934	55.568	62.963	63.937	49.560	57.595	50.779	57.512	64.226	63.045	57.228	76.624	55.091	80.137
1995	71.321	64.893	47.904	54.384	60.059	62.080	65.561	45.271	58.050	71.112	71.226	49.267	49.196	56.122	48.251
1996	64.328	61.308	59.352	54.348	56.264	60.731	68.106	56.818	77.548	62.557	67.829	56.223	62.162	52.850	68.078
1997	57.568	61.636	68.133	67.693	61.106	72.794	88.186	63.821	65.976	76.679	65.711	67.331	67.473	51.622	55.840
1998	69.132	54.026	48.775	63.200	72.702	75.368	74.736	52.774	74.575	79.906	70.836	58.981	55.793	69.988	50.025
1999	61.189	55.382	53.800	58.300	59.766	54.742	59.394	52.798	56.161	62.183	58.657	55.465	48.015	52.637	41.021
2000	63.748	60.774	49.887	51.297	56.810	78.438	72.151	42.474	79.996	59.083	87.198	52.458	61.180	64.839	71.109
2001	59.971	62.241	50.926	45.528	56.949	52.110	50.091	47.236	61.490	51.264	54.640	44.656	45.342	49.177	40.875
2002	66.894	61.174	50.207	44.795	44.259	193.464	247.100	43.085	286.364	243.319	106.144	39.081	42.791	260.674	42.282
2003	58.980	60.607	53.179	48.485	60.270	51.754	64.922	46.713	64.431	71.522	67.628	57.753	65.368	60.469	35.899
2004	66.520	71.982	64.808	60.323	60.312	46.834	57.361	50.897	49.199	53.868	56.939	47.329	57.128	46.161	44.808
2005	58.732	89.425	75.931	58.146	61.129	57.079	69.301	61.830	72.213	71.974	73.316	47.533	49.897	48.763	43.234
2006	65.417	64.917	59.844	57.578	60.568	58.226	75.970	56.008	73.475	73.299	63.617	47.944	45.885	62.103	41.439
2007	60.077	73.530	82.983	84.694	80.060	68.072	57.546	62.977	51.051	60.400	64.340	70.076	65.701	54.872	46.035
2008	55.236	58.348	54.989	59.000	52.150	60.809	62.676	55.128	68.756	71.411	70.715	57.823	54.695	67.875	46.877
2009	59.455	64.307	57.934	54.651	57.231	57.128	56.872	47.267	52.801	62.763	61.981	52.412	56.859	66.692	39.955
2010	60.705	46.087	47.170	44.514	48.691	63.522	72.636	38.205	63.286	61.587	55.887	36.779	50.373	51.360	38.815
2011	55.688	60.868	51.858	48.819	64.579	46.686	54.541	45.605	50.109	54.591	55.959	59.553	56.547	60.775	53.210
2012	63.866	57.943	53.634	49.901	48.723	54.998	64.928	51.342	62.073	62.364	69.239	66.768	79.733	53.920	68.980

Table B.5 Annual Maximum Rainfall of GLADS for 0.25 by 0.25 grid Size (mm)

GLADS 1-day for 0.5 by 0.5 grid Size, year 1983-2012																
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Longitude	34.6	34.6	34.6	35.1	35.4	35.4	35.6	35.6	35.6	35.9	35.9	36.1	36.1	36.1	36.1	36.1
Latitude	10.1	9.9	9.6	9.9	9.6	8.1	9.4	9.1	8.1	9.1	8.9	10.6	9.4	9.1	8.4	7.9
1983	143.221	131.401	119.588	115.875	91.984	123.146	93.938	76.178	125.532	68.482	87.765	69.558	65.985	60.787	78.934	53.538
1984	62.994	55.320	77.442	47.597	78.966	63.569	91.964	87.582	66.161	80.081	84.270	58.709	73.755	72.586	81.743	53.052
1985	41.772	37.759	42.366	43.681	42.170	39.901	48.151	47.304	39.201	49.762	48.239	58.184	64.342	67.770	94.000	57.419
1986	79.137	50.620	44.916	62.679	52.707	57.432	56.376	55.278	53.028	45.412	52.422	93.256	54.793	53.131	71.214	53.600
1987	67.430	68.455	95.833	61.030	104.315	74.145	139.391	134.778	81.010	146.830	143.001	76.293	161.942	158.890	138.987	89.893
1988	91.318	85.504	96.072	77.190	81.402	89.799	74.553	74.979	86.061	77.083	71.508	57.664	115.685	107.367	78.448	46.915
1989	69.372	66.433	93.007	77.073	115.357	61.739	104.192	74.423	66.922	63.934	69.164	103.773	75.630	76.163	69.569	51.618
1990	69.213	89.036	122.228	92.526	128.597	94.323	118.578	124.669	94.918	104.354	111.171	87.013	77.696	84.046	91.948	67.917
1991	67.641	59.736	71.047	80.073	132.626	66.730	128.051	98.366	64.905	70.263	49.060	72.776	64.681	56.764	87.664	59.579
1992	82.368	80.350	101.155	91.989	114.091	109.739	122.329	125.006	106.972	118.416	120.722	61.556	109.888	111.825	105.618	94.508
1993	96.660	79.177	98.614	85.805	93.182	63.912	82.322	80.572	66.164	76.350	74.926	59.875	87.488	84.956	76.787	52.707
1994	60.464	83.773	117.288	64.891	127.189	66.478	145.580	129.900	77.332	106.164	109.274	85.186	95.861	98.344	110.652	54.918
1995	60.672	67.612	94.653	41.218	67.236	79.289	67.236	63.455	72.528	49.304	51.947	56.434	83.382	80.479	64.066	42.217
1996	82.437	86.359	90.282	55.029	78.426	72.226	73.054	71.333	64.907	71.290	73.874	47.929	69.135	71.248	71.397	63.102
1997	127.844	133.462	139.087	132.723	129.451	69.511	132.976	118.053	74.572	108.812	106.784	97.481	115.642	106.421	77.131	73.673
1998	60.760	84.388	115.708	83.849	114.632	100.214	121.980	127.319	92.096	123.055	126.878	62.225	116.491	118.791	112.791	75.798
1999	49.896	44.221	53.823	64.326	81.077	53.983	87.233	79.262	50.427	80.230	71.332	86.573	91.029	81.198	55.930	61.798
2000	55.378	40.541	55.093	42.363	75.155	56.927	84.026	75.727	60.342	62.216	57.317	63.413	54.460	50.781	67.465	65.325
2001	105.267	100.291	140.409	146.623	237.706	104.069	230.422	183.423	97.589	131.013	97.446	117.046	98.749	78.609	103.512	70.888
2002	65.368	65.975	69.727	54.755	74.205	42.794	70.515	68.468	40.033	51.859	50.039	101.638	50.709	38.061	43.965	37.123
2003	65.863	60.667	73.542	68.396	108.157	80.177	127.591	124.021	78.837	112.720	108.009	87.737	107.263	101.412	77.817	42.962
2004	68.881	47.265	66.174	53.599	55.787	41.608	60.125	47.843	44.794	53.732	50.916	57.484	67.217	61.929	56.770	48.490
2005	65.742	51.143	69.561	100.016	162.637	80.352	172.260	160.474	82.283	121.811	113.336	117.796	96.280	83.148	61.527	59.586
2006	53.061	57.051	61.036	68.426	79.596	53.502	74.798	57.694	52.703	62.448	61.106	87.607	92.340	97.096	97.466	51.451
2007	54.665	66.555	78.451	45.347	60.002	53.091	67.366	72.109	54.419	70.081	73.392	40.344	66.161	68.046	66.906	43.481
2008	50.449	47.966	45.484	36.718	51.703	55.400	51.231	45.090	55.547	42.868	39.052	37.060	48.756	40.648	47.221	52.961
2009	46.437	56.331	78.862	44.602	87.415	48.892	102.266	85.764	48.304	79.024	62.912	33.752	88.010	72.285	53.952	44.271
2010	30.855	30.245	40.754	48.081	89.212	34.173	87.785	62.700	40.449	44.783	42.831	68.191	60.192	50.639	47.991	51.608

....Con't																
Grid No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Longitude	36.1	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.6	36.6	36.6	36.6	36.6	36.6	36.9
Latitude	7.6	12.9	11.4	10.9	9.4	9.1	8.9	8.6	8.4	9.9	9.1	8.9	8.6	8.1	7.9	11.4
1983	63.780	68.166	76.931	72.697	80.449	57.465	78.408	108.562	109.692	84.226	73.995	79.412	109.660	81.912	73.652	96.286
1984	66.005	73.968	81.460	68.040	66.506	66.916	77.131	89.168	87.059	57.325	81.635	80.435	96.280	71.493	57.458	71.900
1985	58.048	40.965	111.074	69.569	84.599	90.541	96.487	126.354	130.693	67.643	96.643	106.378	143.023	113.946	82.350	117.074
1986	65.815	114.657	149.537	85.963	71.178	60.848	69.258	96.965	98.126	62.689	59.477	85.685	111.901	80.801	74.003	151.681
1987	76.894	47.213	65.817	79.516	173.217	170.942	168.674	166.400	153.896	126.728	166.050	163.920	161.797	130.005	109.517	52.051
1988	50.855	67.133	74.518	56.676	148.713	137.651	126.586	115.524	103.810	107.620	148.851	133.296	117.736	82.040	59.682	49.971
1989	53.071	51.315	110.646	123.993	92.562	88.397	84.230	80.065	75.471	85.628	97.796	91.187	84.583	56.066	63.979	112.746
1990	58.609	98.737	96.271	87.013	108.777	83.773	79.055	95.832	93.564	145.392	95.495	73.640	89.143	61.052	54.118	79.437
1991	60.078	76.074	176.678	91.332	85.409	76.641	98.238	121.117	117.595	75.434	89.886	113.653	137.419	93.318	58.724	128.487
1992	105.421	81.204	71.898	70.373	103.667	105.242	106.810	108.384	96.695	94.835	89.204	90.415	91.627	75.764	104.930	64.975
1993	56.564	79.402	125.845	92.463	122.484	118.937	115.383	111.830	101.590	93.496	134.880	130.771	126.656	95.997	76.929	110.393
1994	53.644	58.520	77.847	85.186	85.226	96.816	108.409	119.999	114.294	118.830	88.141	99.066	114.751	81.460	63.122	63.575
1995	59.104	75.051	111.475	66.200	116.395	111.650	106.905	102.162	87.315	78.846	115.502	109.866	104.232	63.385	48.594	122.615
1996	71.487	44.403	77.082	66.966	96.785	71.205	76.899	82.593	74.760	89.261	79.471	75.178	77.365	78.084	91.297	64.588
1997	101.021	97.236	100.108	89.200	117.145	109.745	102.352	94.951	79.847	93.320	100.044	93.343	86.644	67.303	70.686	70.470
1998	82.906	154.997	131.653	79.123	113.743	114.528	115.305	116.089	107.263	61.443	100.336	101.691	103.038	86.067	99.079	134.579
1999	66.874	104.477	174.526	122.848	92.924	82.164	71.398	60.638	56.813	92.404	82.701	70.376	58.053	68.213	83.694	152.410
2000	91.459	113.992	125.232	100.926	59.756	63.490	76.666	89.842	87.331	50.938	67.536	82.846	98.159	77.946	88.527	192.093
2001	89.909	55.458	76.788	117.046	123.852	101.152	94.097	130.594	136.376	132.039	111.495	104.257	128.323	108.888	88.153	76.094
2002	50.745	76.676	135.262	101.638	70.994	53.284	53.678	62.862	59.518	112.882	56.575	52.968	62.202	51.062	59.130	107.877
2003	57.659	139.281	75.433	83.131	97.096	90.111	83.119	79.224	70.924	84.117	94.170	89.824	85.480	52.302	72.384	66.369
2004	59.481	78.395	134.071	90.033	77.838	71.177	72.883	74.592	74.541	80.728	79.689	76.391	74.377	53.130	65.071	130.954
2005	68.164	80.078	147.517	106.216	120.159	95.450	70.742	68.746	65.336	84.318	99.323	75.604	71.559	69.990	77.566	156.298
2006	64.282	94.440	100.229	79.067	129.282	135.931	142.586	149.234	136.456	97.093	156.848	163.400	169.951	118.761	82.450	62.234
2007	48.540	47.526	54.853	42.751	65.565	66.018	66.478	66.938	63.303	50.226	59.956	59.868	59.778	52.080	46.976	46.063
2008	60.491	61.768	43.754	37.038	52.195	40.637	46.097	54.323	54.496	44.193	41.944	43.143	53.678	46.826	45.453	37.232
2009	47.021	60.794	60.974	39.126	80.881	65.547	53.866	74.866	74.894	46.423	54.604	54.566	76.391	54.566	48.477	55.156
2010	53.418	54.858	73.632	81.958	70.587	60.056	59.712	63.621	58.436	90.020	56.669	57.380	63.342	51.927	58.780	74.987

....Con't																
Grid No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Longitude	36.9	36.9	36.9	36.9	36.9	36.9	36.9	36.9	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Latitude	10.9	10.6	9.1	8.6	8.4	8.1	7.9	7.6	12.6	12.4	11.4	10.6	9.9	9.6	9.1	7.9
1983	82.344	112.152	90.629	81.130	81.334	67.878	66.738	75.403	96.207	94.303	101.859	112.716	86.460	87.013	107.270	68.664
1984	60.320	55.080	97.525	91.854	92.564	67.739	52.780	73.891	94.433	94.433	78.209	57.678	81.427	108.341	113.414	53.078
1985	69.690	97.565	86.080	140.262	138.564	107.732	76.905	56.532	87.061	85.052	110.497	100.552	72.807	83.132	101.096	71.466
1986	97.012	114.495	83.453	114.067	107.649	79.509	68.747	92.502	92.229	112.024	138.869	128.738	68.070	88.206	107.422	70.158
1987	55.879	63.775	144.202	138.974	128.773	110.987	93.201	75.412	96.367	92.108	79.645	75.891	91.859	115.291	122.353	76.883
1988	48.070	56.386	140.972	97.367	85.695	67.431	52.021	72.835	92.161	83.577	83.284	63.439	109.480	153.271	133.096	52.741
1989	108.742	129.292	104.354	90.785	76.470	54.953	61.123	67.297	83.191	83.854	110.782	108.865	98.546	120.585	110.918	58.270
1990	90.474	126.665	94.998	63.675	60.674	43.609	40.699	48.778	90.908	95.254	78.608	118.299	141.776	144.407	94.495	36.042
1991	68.658	71.410	97.425	135.420	126.807	90.573	54.346	66.424	84.217	78.084	83.474	61.495	59.296	73.577	104.966	53.537
1992	86.751	107.486	63.718	65.448	57.646	61.910	81.516	109.456	82.464	85.591	71.034	113.481	96.215	85.568	61.670	60.096
1993	85.951	77.626	132.790	124.357	113.034	94.605	76.176	73.943	121.487	122.835	88.115	65.512	97.032	121.783	130.702	75.416
1994	104.833	146.772	82.798	89.327	85.938	70.645	75.557	80.916	68.850	70.015	61.988	153.751	139.320	124.759	94.265	87.992
1995	89.560	73.036	92.037	80.884	68.334	48.807	38.287	51.026	77.630	66.543	119.420	88.543	53.240	68.972	68.564	38.932
1996	58.884	65.375	80.384	60.282	59.415	68.487	77.559	86.631	54.123	57.147	48.918	85.783	91.535	117.229	81.298	63.822
1997	65.449	75.494	77.307	80.009	76.298	63.420	59.171	82.297	89.123	81.656	50.391	79.539	59.192	73.425	68.967	48.981
1998	83.283	60.076	76.231	84.240	79.749	79.177	89.614	118.681	144.017	152.401	131.795	64.939	69.495	88.422	90.583	83.430
1999	149.967	148.748	82.807	53.765	52.136	65.429	78.728	92.027	137.295	157.815	157.892	155.578	89.003	101.661	84.705	73.762
2000	105.294	89.243	62.911	94.854	93.956	76.183	81.112	92.638	120.337	123.320	229.703	81.097	58.710	65.864	58.291	75.984
2001	105.046	147.061	105.961	95.139	96.584	80.244	78.335	107.433	92.891	96.607	90.595	120.256	79.548	97.051	100.427	68.525
2002	121.636	170.288	49.449	48.263	50.803	49.721	58.989	77.787	61.246	61.914	76.739	175.550	121.623	90.020	50.749	58.849
2003	60.502	63.465	95.450	75.622	76.958	58.026	79.672	104.168	178.511	166.603	85.466	82.020	99.844	113.530	96.733	86.955
2004	90.603	70.425	78.888	71.647	61.104	51.147	62.888	84.240	127.617	133.397	116.109	65.558	80.579	88.614	89.430	60.707
2005	72.913	78.421	87.670	72.968	67.172	72.142	79.931	87.720	92.996	111.284	148.100	80.028	68.040	80.726	84.055	82.886
2006	54.728	67.418	159.849	168.752	153.324	118.017	82.710	85.257	89.098	81.752	81.205	73.833	105.250	141.296	162.842	82.968
2007	40.026	46.094	49.858	50.354	48.551	44.693	42.973	48.241	42.494	43.482	63.221	50.217	43.993	48.626	41.323	39.679
2008	31.650	41.312	42.767	45.190	46.820	46.834	50.641	54.443	58.950	53.996	35.526	43.715	40.265	45.516	43.590	55.831
2009	38.224	39.532	41.499	60.637	63.361	57.555	51.749	55.105	65.812	70.999	46.142	36.483	47.313	54.345	43.408	55.028
2010	78.530	88.188	52.566	51.218	47.271	45.005	57.186	80.060	95.651	84.629	68.869	74.832	74.073	79.652	57.037	56.856

….Con't																
Grid No.	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Longitude	37.1	37.4	37.4	37.4	37.4	37.4	37.4	37.4	37.4	37.6	37.6	37.6	37.6	37.6	37.9	37.9
Latitude	7.6	12.6	12.4	11.6	11.4	10.6	10.4	9.6	7.9	12.9	11.9	11.4	10.9	10.4	11.9	11.1
1983	81.654	99.726	98.755	109.444	107.432	113.288	120.911	82.776	96.126	64.435	74.229	96.442	70.984	106.388	53.018	55.922
1984	67.340	132.205	132.205	81.692	84.527	68.686	64.869	125.147	58.899	94.433	59.114	78.062	59.185	65.814	47.831	46.876
1985	57.485	106.708	105.044	111.105	127.195	128.517	112.642	90.390	66.025	75.817	84.933	136.650	139.676	124.224	75.317	124.669
1986	87.467	71.578	73.731	133.917	135.432	142.988	144.884	123.489	71.934	82.950	95.256	122.064	93.817	132.981	73.509	74.157
1987	69.616	110.178	104.430	94.316	107.233	103.888	90.417	112.940	64.339	88.834	71.504	114.903	118.390	105.877	62.578	109.972
1988	73.840	97.496	89.056	116.439	116.598	88.808	88.808	154.574	53.460	79.345	86.061	116.598	63.439	89.787	68.079	78.393
1989	62.703	86.274	86.680	111.890	108.825	94.073	93.606	142.514	55.417	62.551	79.747	96.400	79.512	94.161	69.803	90.911
1990	41.809	79.600	83.609	93.284	100.859	109.927	128.498	145.703	40.404	52.518	67.988	103.531	92.074	108.929	56.996	81.713
1991	67.489	77.652	71.701	80.285	85.785	71.455	63.971	86.243	67.489	60.893	66.614	95.969	80.193	61.414	75.894	88.413
1992	77.663	87.237	97.434	89.442	77.099	119.477	121.636	84.545	68.377	69.502	85.994	70.114	93.461	108.235	64.738	66.664
1993	70.118	121.796	122.485	60.104	65.843	61.147	72.168	120.074	74.663	84.776	64.450	52.209	53.880	70.196	72.999	77.563
1994	98.632	72.717	72.777	82.204	84.661	160.730	176.865	135.905	100.434	66.299	73.002	83.994	103.306	160.330	67.494	60.789
1995	40.649	82.095	74.422	103.473	116.225	104.043	89.262	65.843	40.348	79.849	62.947	100.297	98.645	89.705	68.441	72.705
1996	68.863	51.214	53.907	50.777	57.389	106.195	105.935	118.586	68.464	55.813	43.397	57.154	73.263	105.470	40.779	51.170
1997	67.677	114.734	104.530	63.685	69.169	93.966	87.694	81.998	40.501	115.195	53.973	72.243	79.361	87.735	46.857	53.484
1998	111.963	155.742	159.814	142.407	129.005	77.826	77.648	119.497	78.202	133.105	137.652	135.597	122.846	99.121	143.046	203.351
1999	84.871	165.663	187.741	178.199	163.380	162.402	142.077	110.614	68.794	112.402	168.027	145.359	145.178	126.911	121.369	103.764
2000	83.249	111.792	111.931	263.266	267.313	98.554	98.554	70.883	70.850	98.361	181.637	250.348	135.678	98.832	131.746	137.868
2001	92.197	97.213	101.175	108.181	107.250	93.450	94.639	90.137	58.774	65.647	75.632	101.133	75.541	71.176	89.392	104.869
2002	75.664	65.646	62.546	87.849	87.849	180.811	190.512	93.740	58.707	62.502	65.229	90.209	116.075	171.337	52.262	55.145
2003	112.112	184.764	174.252	91.210	104.561	106.476	98.872	122.705	94.242	150.588	91.686	102.860	107.109	101.429	69.066	83.672
2004	80.333	128.492	133.507	96.597	101.263	64.702	74.857	98.023	58.524	80.585	77.041	97.897	61.353	65.902	73.425	52.071
2005	90.396	116.791	133.315	156.092	139.903	82.335	76.717	111.093	85.847	92.804	133.555	118.830	79.011	72.861	99.576	121.383
2006	81.849	123.801	114.450	110.268	111.786	80.242	79.996	146.756	83.226	108.929	88.221	111.196	56.002	73.183	84.640	58.243
2007	45.024	44.361	45.094	83.447	84.851	54.335	54.495	53.584	37.719	45.391	71.177	90.406	55.548	54.983	73.426	61.412
2008	58.765	77.022	69.412	42.631	44.001	49.657	48.799	45.336	61.020	86.942	48.942	48.203	39.133	47.283	42.133	46.738
2009	50.946	66.085	71.448	56.050	47.904	40.541	36.973	74.448	58.301	70.878	56.112	45.720	38.546	35.779	43.597	30.203
2010	79.594	108.637	95.885	59.435	62.759	66.200	71.798	75.881	56.525	99.196	44.550	56.583	71.235	72.667	44.291	72.794

....Con't																
Grid No.	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Longitude	37.9	37.9	38.1	38.1	38.1	38.1	38.1	38.1	38.4	38.4	38.4	38.4	38.4	38.6	38.6	38.6
Latitude	9.6	8.9	10.9	10.6	10.4	10.1	9.4	9.1	11.9	11.6	10.9	9.9	8.9	10.9	10.6	9.9
1983	70.643	124.239	61.625	59.253	53.248	43.620	75.946	87.057	110.552	119.601	86.275	57.392	72.101	103.259	100.699	56.361
1984	85.158	100.272	46.752	45.626	44.220	49.205	66.226	72.714	39.379	54.302	56.414	73.722	62.805	53.924	57.134	70.969
1985	66.835	80.622	115.201	119.232	106.166	76.005	70.541	65.318	56.084	78.518	102.961	60.115	64.867	86.618	93.131	67.880
1986	90.046	82.147	80.717	80.158	74.622	57.160	77.008	71.804	117.967	161.860	111.109	70.568	92.030	116.653	92.094	79.860
1987	72.122	60.738	116.193	129.095	118.597	84.713	60.975	64.076	59.551	82.013	115.098	53.557	73.617	100.517	118.932	48.056
1988	101.742	52.413	104.885	113.804	106.969	84.386	59.510	45.478	87.266	122.174	135.784	81.801	50.304	143.429	160.798	92.340
1989	113.406	98.619	90.555	87.237	75.185	54.393	93.720	91.200	162.875	194.990	96.071	50.553	78.738	87.438	88.292	40.799
1990	91.472	59.603	71.105	71.797	63.738	50.147	73.094	70.969	45.967	60.314	65.407	55.602	78.071	57.232	63.746	57.050
1991	68.825	87.588	79.322	64.904	55.155	49.866	58.663	65.708	94.452	112.720	83.877	44.032	97.543	80.488	66.356	51.646
1992	55.842	70.002	79.447	82.753	75.706	58.294	84.039	82.632	56.522	77.226	93.322	67.951	94.649	96.539	106.393	64.869
1993	80.592	79.702	91.625	70.358	54.852	53.015	72.433	68.526	141.464	173.057	121.132	64.883	73.120	135.704	108.449	66.865
1994	123.803	84.212	100.222	136.680	137.222	101.840	112.687	107.014	62.992	84.992	136.680	104.644	132.607	152.436	213.412	99.040
1995	61.471	58.059	95.167	109.344	102.687	76.827	89.193	72.498	109.158	149.482	133.231	102.876	87.116	152.703	180.336	109.398
1996	74.602	76.243	56.336	65.898	67.263	77.272	101.590	72.568	64.346	71.458	64.435	109.972	96.211	63.064	80.921	103.872
1997	59.363	45.776	61.733	74.251	72.009	59.156	65.770	48.509	71.150	99.617	79.965	66.666	51.829	86.259	100.704	75.031
1998	84.398	79.168	268.672	259.861	223.522	159.656	81.408	63.062	241.179	324.836	341.583	122.449	65.168	336.072	323.242	118.811
1999	139.106	94.783	101.920	100.792	94.551	103.745	151.185	124.805	94.778	124.985	136.159	145.081	102.066	139.303	138.538	151.807
2000	53.403	59.274	90.828	117.925	118.215	91.686	43.119	43.060	150.291	209.382	127.157	91.219	38.697	144.655	189.362	111.689
2001	59.715	57.056	140.289	139.135	121.267	86.687	63.195	58.884	139.540	169.455	189.800	88.890	91.526	209.597	216.945	97.524
2002	78.297	39.432	70.798	87.356	83.681	77.760	57.272	43.786	79.717	108.961	90.832	58.080	50.685	92.315	117.888	64.110
2003	81.583	67.409	74.598	71.319	66.476	55.119	75.099	63.360	110.388	152.849	101.184	72.179	87.096	107.808	85.186	80.514
2004	77.283	74.990	58.227	63.479	57.840	59.953	128.543	119.392	66.180	53.638	79.180	118.623	149.405	78.447	85.536	133.332
2005	89.625	86.579	150.854	135.426	111.896	80.266	72.615	69.867	181.745	225.763	186.773	60.860	88.396	192.339	161.404	64.389
2006	94.654	104.088	54.746	58.062	55.359	45.995	113.051	121.022	96.034	126.976	69.736	93.846	179.243	80.775	81.927	93.351
2007	51.326	40.195	48.709	49.621	50.142	46.345	44.913	38.984	77.924	69.999	47.418	42.255	43.073	44.902	44.902	41.415
2008	36.434	55.783	51.637	53.474	47.592	33.994	43.204	51.182	60.159	40.886	57.893	33.931	62.541	53.477	59.290	32.146
2009	52.812	61.566	30.858	38.599	43.222	44.731	44.887	51.777	59.178	53.933	36.786	49.306	59.950	38.245	51.950	49.038
2010	69.044	55.622	86.336	90.994	81.654	58.326	65.988	55.371	68.066	74.892	93.891	50.026	82.628	85.458	87.778	43.597

....Con't																	
Grid No.	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0	91.0	92.0	93.0	94.0	95.0	96.0	97.0
Longitude	38.6	38.9	38.9	38.9	39.1	39.1	39.1	39.4	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.9	40.1
Latitude	9.4	10.9	10.6	9.9	12.1	11.6	10.1	9.6	11.9	11.6	11.4	11.1	10.4	9.6	9.1	8.9	11.1
1983	85.7	112.6	112.5	52.3	118.9	143.2	82.1	55.0	117.8	129.6	118.5	114.0	111.0	54.0	54.0	50.4	51.0
1984	93.2	39.3	40.8	58.4	38.9	61.1	37.4	62.2	48.1	55.7	54.6	48.9	56.7	50.4	53.7	55.3	22.4
1985	67.5	66.8	93.6	66.2	36.3	64.3	78.0	52.8	60.6	84.8	90.0	76.2	86.6	48.5	42.6	33.2	62.4
1986	123.2	97.4	83.9	80.3	64.1	100.9	63.1	113.9	105.7	130.3	126.4	93.9	74.1	100.7	102.3	69.9	41.4
1987	68.2	72.4	85.2	34.6	50.7	65.8	65.9	50.4	52.6	70.8	72.0	62.9	114.4	54.8	47.8	50.5	26.9
1988	54.5	127.8	148.8	93.4	120.4	92.9	116.3	98.0	104.3	87.7	94.4	85.4	110.3	99.2	71.9	36.2	47.8
1989	65.6	79.7	76.2	37.9	144.2	183.7	49.8	93.6	132.4	140.3	126.3	90.2	83.7	94.0	86.5	60.4	38.6
1990	81.3	59.0	62.3	57.2	51.7	58.5	52.9	63.7	46.4	60.0	66.1	61.2	44.0	56.6	40.7	39.3	65.0
1991	78.4	69.1	49.8	54.3	80.3	108.0	55.0	84.6	79.8	90.1	83.3	71.9	107.9	82.4	79.7	50.6	62.2
1992	100.8	89.1	98.9	62.1	54.6	78.7	68.3	166.6	55.2	77.3	77.3	69.6	109.1	164.4	143.1	81.6	51.4
1993	98.4	135.3	113.6	68.0	122.3	164.9	86.7	89.8	117.8	129.3	131.6	124.6	106.9	84.5	69.4	43.4	53.4
1994	153.9	147.5	206.5	99.4	49.5	63.5	152.5	82.0	66.9	84.5	87.9	89.5	169.9	84.9	98.7	108.9	104.5
1995	139.4	153.6	191.1	104.7	165.3	188.3	164.2	114.5	206.4	233.0	224.5	181.2	201.0	98.6	97.0	69.5	77.6
1996	142.8	62.4	75.3	83.7	60.4	82.8	85.1	114.8	62.9	74.5	72.0	55.4	113.0	114.8	82.0	47.3	28.5
1997	105.5	76.2	88.0	74.7	59.5	87.4	94.5	108.4	81.9	98.7	94.2	86.3	123.7	115.1	92.2	80.4	60.2
1998	104.8	252.1	234.9	84.9	137.9	205.4	145.5	110.8	126.5	175.2	215.0	245.9	282.8	118.3	128.9	116.3	143.3
1999	159.3	111.3	117.2	148.2	128.3	92.8	141.3	138.1	93.0	91.9	104.0	101.8	131.8	116.6	72.8	51.8	80.8
2000	51.9	143.3	190.7	126.6	86.3	164.0	171.7	130.9	166.0	230.3	229.6	164.0	183.5	123.2	97.1	61.8	84.5
2001	81.2	199.7	224.9	102.2	128.8	171.1	159.0	129.6	132.8	182.3	181.8	149.2	215.0	129.9	96.5	79.5	84.0
2002	51.1	91.8	97.7	63.9	77.4	122.2	77.0	59.8	105.9	129.5	128.5	102.9	102.4	53.9	47.8	31.7	51.0
2003	107.3	94.5	82.5	86.1	63.1	92.5	73.8	123.4	76.7	107.4	110.6	86.2	85.4	113.6	97.0	65.3	37.0
2004	193.3	56.0	61.1	133.4	59.4	101.6	90.9	174.0	104.3	143.1	142.4	102.1	55.3	152.7	105.6	45.2	46.0
2005	82.8	167.6	132.5	82.5	143.0	221.1	126.3	100.0	147.8	176.9	172.1	133.2	166.5	97.4	112.6	87.3	73.6
2006	155.3	82.9	89.1	97.9	117.0	118.4	98.2	156.4	88.8	124.4	129.6	104.6	93.9	162.2	151.0	119.6	67.6
2007	42.6	44.6	42.0	40.4	88.9	66.1	38.2	41.0	67.0	57.7	55.5	47.6	40.7	40.0	50.4	46.7	36.8
2008	44.0	38.4	42.6	26.6	76.2	54.2	36.2	50.0	59.2	54.7	48.2	39.5	51.2	50.8	44.6	38.8	31.4
2009	41.7	36.6	46.5	47.9	99.4	51.3	47.0	55.5	63.6	75.3	79.9	67.5	42.5	51.4	34.8	28.9	40.4
2010	62.0	69.2	78.8	45.3	87.0	116.0	73.5	62.4	123.9	165.1	167.6	131.5	100.8	69.9	63.4	57.3	64.5

GLADS- 2 day for 0.25 by 0.25 grid Size, year 1983-2010																
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Longitude	34.63	34.63	34.63	35.13	35.38	35.38	35.63	35.63	35.63	35.88	35.88	36.13	36.13	36.13	36.13	36.13
Latitude	10.13	9.88	9.63	9.88	9.63	8.13	9.38	9.13	8.13	9.13	8.88	10.63	9.38	9.13	8.38	7.88
1983	143.22	131.40	119.59	115.88	92.81	127.10	98.44	85.40	129.92	81.74	92.95	96.76	80.40	78.08	80.41	58.43
1984	65.55	73.76	103.26	56.34	94.07	76.41	104.13	101.49	73.81	100.04	108.32	63.71	88.50	98.59	108.83	59.26
1985	41.77	37.89	50.66	43.68	47.91	48.18	64.02	62.94	47.27	65.97	64.09	68.07	79.44	70.56	136.54	84.98
1986	131.74	82.60	70.93	101.90	71.75	62.51	65.68	58.71	66.31	56.52	59.71	120.52	77.52	69.83	97.12	77.68
1987	95.92	96.49	127.78	88.64	111.31	74.28	146.38	139.77	86.67	150.40	145.14	133.00	164.94	161.03	138.99	106.63
1988	103.47	85.50	96.07	91.29	103.15	93.21	98.75	94.26	89.43	106.95	102.29	87.22	156.97	151.34	122.86	71.05
1989	101.77	90.90	124.78	103.76	153.92	81.22	138.92	99.23	88.11	70.88	78.38	133.65	75.63	76.16	83.88	64.23
1990	101.69	133.86	166.02	132.36	173.15	138.55	161.43	172.31	138.82	143.48	154.54	88.10	103.44	114.67	131.57	87.99
1991	72.24	93.77	130.85	135.09	215.05	89.10	203.54	154.59	86.58	110.42	75.46	76.73	87.23	75.50	113.71	77.09
1992	109.67	101.74	101.15	116.72	127.42	109.74	122.33	125.01	106.97	118.42	120.72	82.27	109.89	111.83	105.62	97.53
1993	116.75	107.08	135.05	116.26	134.84	85.22	117.21	109.58	88.13	96.84	94.92	72.18	96.57	95.55	102.23	69.55
1994	67.02	111.70	156.38	86.52	169.59	88.64	194.02	172.93	103.11	140.73	138.63	113.58	127.36	124.05	147.54	83.29
1995	69.59	67.61	94.65	59.24	89.65	107.81	89.65	88.84	101.92	63.45	74.04	75.25	99.70	92.14	74.00	47.70
1996	93.97	98.43	102.89	76.49	84.28	98.81	92.91	94.52	95.07	93.27	97.43	69.24	118.30	97.74	95.20	80.59
1997	127.84	133.46	139.09	132.72	129.66	69.51	132.98	118.05	76.50	108.81	106.78	116.25	115.64	106.42	77.13	100.82
1998	71.40	113.60	155.81	116.00	160.99	133.85	161.25	153.41	122.47	123.06	126.88	77.06	116.49	118.79	112.79	92.66
1999	69.12	72.75	80.33	81.38	104.15	74.96	112.97	101.66	78.21	103.68	91.28	115.43	119.22	105.71	75.95	75.15
2000	70.65	49.93	62.53	43.95	80.17	78.09	91.90	87.44	83.01	74.76	76.36	84.55	91.99	74.07	87.03	87.10
2001	148.26	118.88	140.41	146.62	237.71	177.39	230.42	183.42	166.10	131.01	97.45	159.56	111.37	103.40	136.37	138.30
2002	78.59	78.41	82.30	72.26	98.69	60.92	90.76	74.66	58.97	61.72	65.48	141.11	69.54	60.27	65.43	59.42
2003	88.45	80.44	97.90	83.17	143.17	115.96	170.12	165.36	108.19	150.29	144.01	113.84	143.02	135.22	107.62	75.19
2004	68.88	61.04	76.26	59.35	72.26	54.54	76.40	75.98	53.50	59.33	60.11	57.48	69.12	66.06	80.93	64.35
2005	98.37	85.73	111.08	115.45	169.84	84.92	173.29	161.25	86.73	124.14	114.91	158.28	133.82	117.75	70.51	80.01
2006	96.80	90.31	83.99	91.33	95.47	71.27	87.21	74.53	70.61	81.53	78.74	119.18	92.68	97.10	97.47	61.21
2007	66.70	82.15	97.61	61.85	73.61	76.35	70.37	72.11	74.88	70.08	73.39	61.19	66.16	68.05	66.91	68.36
2008	58.42	57.91	59.75	49.58	68.78	56.42	68.31	63.69	63.67	62.54	60.93	46.81	65.21	62.63	63.83	64.51
2009	58.05	75.11	105.15	51.25	87.42	54.12	102.27	85.76	50.60	79.02	62.91	41.21	88.01	72.29	62.54	59.03
2010	48.11	48.76	49.39	80.10	125.80	41.56	122.16	87.25	47.42	70.67	53.03	125.48	76.43	64.57	56.75	56.99

Con't																
Grid No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Longitude	36.13	36.38	36.38	36.38	36.38	36.38	36.38	36.38	36.38	36.63	36.63	36.63	36.63	36.63	36.63	36.88
Latitude	7.63	12.88	11.38	10.88	9.38	9.13	8.88	8.63	8.38	9.88	9.13	8.88	8.63	8.13	7.88	11.38
1983	65.41	68.17	102.57	97.44	107.65	77.79	84.46	110.58	109.69	111.58	98.66	86.84	112.46	82.22	77.80	128.38
1984	69.77	94.83	81.46	75.01	95.72	97.15	109.06	120.96	111.73	78.63	114.77	112.93	111.55	77.94	76.61	93.73
1985	62.18	50.39	111.07	80.63	106.21	91.61	122.82	171.94	179.14	91.93	97.19	141.79	190.68	157.00	118.25	117.07
1986	93.92	114.66	150.85	114.15	101.71	83.14	94.20	131.89	133.77	90.19	81.40	116.18	151.90	110.55	97.05	158.89
1987	112.28	59.82	98.58	112.41	174.21	171.66	169.10	166.54	153.90	137.10	170.42	167.68	164.94	131.77	113.49	77.60
1988	67.08	107.18	95.72	78.02	202.35	195.73	189.10	182.48	160.17	143.69	210.66	197.84	185.01	122.80	90.92	66.90
1989	72.51	68.42	112.31	147.95	92.56	88.40	84.23	81.78	78.01	98.92	97.80	91.19	84.58	67.91	81.20	112.75
1990	77.08	124.75	127.20	88.76	116.90	100.38	103.97	125.90	122.86	152.00	103.28	98.07	118.82	81.24	69.12	104.63
1991	62.84	108.72	179.99	93.69	112.82	102.13	123.93	155.98	152.58	102.23	110.40	143.97	177.55	121.46	72.88	128.49
1992	106.43	107.56	79.99	92.74	128.96	115.82	106.81	108.38	96.69	148.29	122.55	106.28	91.63	75.76	107.01	64.97
1993	83.80	87.56	167.79	123.28	122.63	119.38	116.11	112.85	106.07	113.45	136.00	132.48	128.96	99.31	84.43	147.19
1994	88.49	61.42	104.52	113.58	110.33	126.73	143.13	159.53	155.55	158.44	117.52	132.09	152.77	111.30	125.17	76.14
1995	63.02	99.74	111.96	75.25	138.08	127.14	116.20	105.26	87.31	97.09	134.15	124.03	113.90	68.02	58.62	124.98
1996	85.81	68.13	102.36	87.21	148.42	116.96	100.03	109.29	99.68	126.19	127.04	100.48	111.04	88.75	95.87	83.15
1997	129.33	105.10	133.80	115.02	117.15	109.75	102.35	96.44	93.94	103.66	100.04	100.64	109.04	89.65	97.22	93.96
1998	124.95	226.84	173.54	104.09	113.74	114.53	115.31	116.09	107.26	79.46	100.34	101.69	109.10	104.44	125.11	170.83
1999	77.69	139.30	174.53	163.80	122.34	107.73	93.10	78.49	73.09	122.57	109.14	92.64	76.14	77.73	88.70	203.98
2000	121.94	159.25	166.98	134.57	106.41	84.25	100.68	118.02	113.90	88.01	88.39	108.81	129.24	98.20	118.94	256.12
2001	139.26	68.41	101.12	163.03	145.94	136.04	126.13	137.40	159.74	147.40	148.66	139.01	129.97	162.52	171.86	100.45
2002	68.96	112.63	227.78	141.11	95.95	71.11	75.68	93.21	89.29	158.62	78.25	84.21	101.85	69.17	73.90	183.95
2003	76.62	139.28	104.28	108.00	129.46	120.15	110.83	101.51	92.36	116.62	122.41	114.52	106.63	71.99	94.91	84.50
2004	79.07	78.40	149.78	96.76	96.78	92.48	89.16	113.92	110.72	80.73	105.30	100.27	112.98	78.51	83.95	146.28
2005	91.23	90.26	200.70	142.84	167.84	150.15	132.47	114.78	95.11	111.49	154.84	139.14	123.44	96.48	106.72	213.72
2006	85.71	103.43	163.37	118.16	129.28	135.93	142.59	149.23	136.46	97.09	156.85	163.40	169.95	118.76	82.45	119.64
2007	76.28	78.20	89.24	69.68	65.56	66.02	66.48	66.94	63.30	55.68	59.96	59.87	59.78	52.08	57.37	75.72
2008	64.85	62.93	61.58	53.57	66.27	62.72	62.11	66.77	67.53	61.37	58.96	63.49	68.01	64.60	60.83	59.85
2009	57.28	69.33	61.19	47.73	80.88	65.55	55.40	75.38	74.89	60.80	58.60	57.06	76.39	71.19	64.64	55.16

……..

Con't																
Grid No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Longitude	36.88	36.88	36.88	36.88	36.88	36.88	36.88	36.88	37.13	37.13	37.13	37.13	37.13	37.13	37.13	37.13
Latitude	10.88	10.63	9.13	8.63	8.38	8.13	7.88	7.63	12.63	12.38	11.38	10.63	9.88	9.63	9.13	7.88
1983	108.98	148.51	120.84	108.17	94.21	72.63	69.70	76.76	96.21	95.52	135.81	149.06	112.81	116.02	143.03	85.07
1984	75.75	66.75	134.99	126.32	111.87	87.28	70.37	98.52	94.43	94.43	101.29	61.75	108.71	146.54	155.21	68.96
1985	92.73	124.33	113.64	186.97	186.38	148.52	110.67	72.82	120.06	117.54	133.50	145.15	91.26	85.52	134.39	103.10
1986	129.35	152.66	112.19	154.25	145.88	108.13	89.30	115.70	92.23	112.02	169.73	171.65	92.73	118.45	143.92	82.02
1987	71.85	72.03	157.33	148.40	136.21	116.29	111.38	113.95	96.37	93.18	113.75	106.05	111.46	139.51	144.24	109.28
1988	63.24	74.90	196.15	147.67	123.78	102.07	80.37	76.23	112.40	102.70	111.50	84.59	146.95	205.73	181.64	69.81
1989	122.57	144.35	104.35	90.78	76.66	65.63	76.92	88.20	110.60	112.60	110.78	119.37	107.27	131.24	110.92	72.64
1990	93.50	130.24	101.55	84.87	80.86	58.03	50.64	51.76	119.07	126.51	102.30	126.49	148.24	151.32	100.02	45.33
1991	69.51	95.21	121.23	176.12	166.11	118.65	71.19	68.11	112.11	104.11	114.44	84.49	104.03	131.43	132.06	69.50
1992	116.25	143.51	107.22	70.89	62.04	61.91	84.88	110.57	96.43	104.41	77.31	151.42	137.65	127.19	91.89	65.07
1993	114.60	98.31	136.14	131.28	120.28	100.70	81.11	113.27	134.85	138.05	117.49	86.87	129.38	149.07	136.28	81.51
1994	139.78	195.70	109.73	119.10	114.58	111.17	130.04	148.90	96.61	97.31	96.88	205.00	185.76	166.35	125.29	134.90
1995	101.40	90.43	113.17	102.93	87.82	62.73	48.71	61.05	103.51	89.63	123.00	113.59	64.49	83.89	92.18	48.43
1996	75.88	77.49	127.99	96.06	87.53	84.07	89.64	98.27	92.56	86.50	64.95	88.89	126.33	163.15	128.94	90.62
1997	84.83	97.68	92.10	106.68	101.65	84.31	79.13	105.49	120.81	108.34	70.18	101.87	69.92	97.90	91.96	61.03
1998	107.35	80.10	87.45	91.30	95.72	102.65	118.39	158.64	238.70	238.89	168.73	82.36	79.88	100.71	107.96	111.67
1999	203.81	203.73	109.96	71.60	65.21	71.60	83.46	98.65	175.72	203.61	211.81	216.43	118.40	135.17	110.77	78.21
2000	140.39	118.99	80.96	124.40	122.41	96.70	94.32	122.89	171.97	175.35	306.27	122.04	74.79	91.73	76.68	85.33
2001	151.75	205.75	141.28	126.85	116.73	129.49	142.24	155.01	123.85	128.42	90.59	172.73	108.21	130.12	133.90	112.63
2002	169.02	236.62	72.22	94.11	88.07	62.91	69.26	92.16	112.19	113.63	133.04	244.01	170.44	127.07	72.64	66.79
2003	100.13	111.48	123.67	92.06	86.96	69.72	103.93	138.12	178.51	166.60	99.08	140.22	155.46	158.82	124.92	112.93
2004	97.42	72.99	104.51	93.95	80.18	57.93	80.23	112.32	127.62	133.40	129.68	74.45	103.04	118.74	118.93	76.51
2005	115.94	104.56	131.80	111.57	96.95	97.06	107.10	117.13	121.29	145.22	203.29	106.70	97.90	116.35	121.54	111.28
2006	92.22	88.88	159.85	168.75	153.32	118.02	82.71	85.52	118.50	109.00	103.54	95.50	105.25	141.30	162.84	82.97
2007	68.40	80.02	49.86	50.35	48.55	44.69	53.10	62.42	81.52	76.69	93.95	78.99	63.85	71.22	55.98	48.83
2008	50.49	52.35	56.48	65.01	66.38	64.71	63.05	63.82	75.49	68.02	61.99	54.16	65.79	69.38	56.53	65.27
2009	47.73	51.63	48.26	80.05	84.48	76.74	69.00	72.33	65.81	71.41	48.28	50.99	64.80	76.18	54.45	73.37
2010	127.45	142.16	66.12	73.42	73.96	63.42	57.19	80.06	127.54	112.84	90.64	118.95	78.64	82.56	76.05	56.86

Con't																
Grid No.	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Longitude	37.13	37.38	37.38	37.38	37.38	37.38	37.38	37.38	37.38	37.63	37.63	37.63	37.63	37.63	37.88	37.88
Latitude	7.63	12.63	12.38	11.63	11.38	10.63	10.38	9.63	7.88	12.88	11.88	11.38	10.88	10.38	11.88	11.13
1983	81.65	99.73	99.16	145.25	143.24	149.62	159.24	110.37	119.10	64.43	97.19	128.69	98.08	140.14	74.73	80.87
1984	89.79	132.20	132.20	105.80	108.85	73.96	75.32	167.53	75.21	94.43	72.90	101.21	69.14	72.61	59.90	60.67
1985	76.82	143.31	141.44	154.30	178.48	191.35	171.77	119.73	95.52	99.93	118.21	190.02	200.45	184.71	106.42	174.09
1986	106.53	114.23	93.67	174.19	180.58	190.65	193.11	164.65	87.69	137.15	127.01	162.75	125.09	177.28	98.01	98.88
1987	111.68	110.18	104.87	135.86	149.89	143.13	124.26	128.23	107.18	89.90	108.67	158.97	162.39	144.38	92.78	150.31
1988	75.88	124.64	115.83	155.25	156.10	118.41	118.41	208.02	59.91	106.97	114.75	156.10	93.36	119.72	90.77	137.77
1989	81.92	114.58	116.69	111.89	108.83	125.37	125.65	157.43	68.36	90.08	79.75	100.65	91.85	127.84	86.56	98.75
1990	51.78	104.19	110.78	123.70	133.58	151.63	141.85	151.92	52.96	68.66	90.65	137.96	130.81	138.90	75.78	108.78
1991	70.84	102.17	95.60	117.86	115.22	96.92	87.55	132.35	70.84	81.17	79.00	110.78	90.72	82.55	75.89	88.41
1992	81.10	95.73	103.71	90.34	92.87	159.34	162.80	117.09	88.61	73.83	85.99	88.08	124.61	144.56	64.74	88.84
1993	108.33	135.29	137.63	100.13	108.30	81.60	96.22	157.90	81.91	94.49	78.84	94.13	73.41	93.56	97.06	105.91
1994	156.11	106.87	106.13	101.77	117.62	214.31	235.82	181.21	139.77	77.85	78.02	111.99	137.52	213.69	67.49	81.05
1995	54.20	111.71	100.89	103.47	121.01	137.55	126.37	87.79	48.16	107.43	72.96	105.01	122.23	128.73	92.72	121.30
1996	98.40	101.41	95.00	72.62	76.48	110.55	110.29	163.07	105.42	92.98	60.46	78.38	76.79	110.42	53.67	74.89
1997	81.62	153.64	138.82	63.69	73.01	108.75	103.74	109.33	54.82	153.59	69.47	72.39	91.44	95.40	64.66	90.63
1998	149.60	223.21	224.54	186.23	166.62	101.05	106.89	123.59	104.95	176.96	180.36	166.33	143.88	113.90	177.37	226.15
1999	91.10	218.44	248.05	238.47	219.64	229.13	201.99	137.68	72.96	149.87	224.00	201.95	202.56	181.80	161.71	142.21
2000	110.01	148.54	154.67	350.17	356.42	140.74	139.61	82.71	76.34	102.68	239.84	333.80	180.90	135.89	173.32	183.82
2001	128.81	129.62	134.77	109.75	107.25	139.71	138.69	120.42	83.01	82.81	90.22	126.00	89.99	106.71	109.71	122.07
2002	86.78	113.77	109.96	117.13	117.79	251.39	265.11	131.98	64.31	100.57	86.14	119.80	160.85	238.19	73.75	72.49
2003	148.48	184.76	174.25	98.62	120.74	168.96	176.57	174.03	121.94	151.31	92.62	119.73	153.67	176.42	73.21	112.44
2004	107.11	128.49	133.51	115.34	113.08	78.94	83.92	134.36	72.78	80.59	87.16	102.45	66.04	76.99	75.75	56.33
2005	120.79	154.82	176.70	207.97	192.86	121.78	123.57	130.77	115.47	122.12	177.46	164.19	105.35	117.75	130.94	161.84
2006	82.01	164.97	152.60	139.40	142.43	102.11	99.86	146.76	83.23	146.24	111.96	143.04	90.63	91.20	108.29	88.50
2007	57.84	78.24	73.63	120.99	122.18	90.41	90.38	83.65	48.47	61.69	103.92	126.61	80.23	85.31	97.54	87.55
2008	67.34	98.39	86.89	61.17	64.13	59.49	64.00	70.42	67.49	115.92	56.32	60.10	47.44	59.22	53.39	48.61
2009	67.24	66.09	71.85	58.90	51.87	56.32	53.62	100.50	77.73	70.88	58.54	49.22	52.30	51.70	46.84	41.38
2010	79.59	144.85	127.85	71.02	83.25	95.76	89.75	91.98	63.12	132.26	61.48	77.15	77.68	72.67	56.00	72.79

Con't																
Grid No.	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Longitude	37.88	37.88	38.13	38.13	38.13	38.13	38.13	38.13	38.38	38.38	38.38	38.38	38.38	38.63	38.63	38.63
Latitude	9.63	8.88	10.88	10.63	10.38	10.13	9.38	9.13	11.88	11.63	10.88	9.88	8.88	10.88	10.63	9.88
1983	95.56	169.13	80.29	74.30	64.41	56.06	104.24	120.47	158.50	172.58	100.75	60.83	104.25	111.87	100.70	57.58
1984	126.74	141.76	54.58	56.59	51.31	54.03	107.77	113.69	56.53	70.75	67.37	76.69	97.47	65.89	72.05	73.06
1985	94.62	112.48	159.70	166.44	151.82	115.85	97.99	90.66	82.86	107.98	139.31	95.25	90.58	115.49	123.41	102.33
1986	120.00	109.88	110.25	86.81	81.46	64.70	105.66	99.70	157.18	215.67	149.02	94.33	124.35	155.54	119.99	106.48
1987	81.87	96.09	156.87	173.81	159.72	114.63	91.89	97.37	80.37	110.13	154.11	73.25	109.59	135.96	161.20	67.50
1988	137.83	76.09	185.44	193.15	176.97	136.89	81.27	73.75	127.55	173.88	231.49	125.61	80.28	243.95	260.97	139.43
1989	129.39	98.62	100.74	99.31	87.17	64.30	106.51	92.74	166.22	198.34	106.10	55.35	78.74	96.89	98.87	52.93
1990	95.14	91.01	94.64	95.50	85.33	66.50	105.93	102.32	61.25	80.40	87.15	81.35	106.40	73.73	84.65	76.07
1991	86.68	114.26	79.32	64.90	56.02	51.67	74.68	79.09	94.45	112.72	83.88	58.71	98.77	80.49	66.36	68.86
1992	76.06	79.03	108.70	114.68	105.81	82.09	105.80	102.75	75.14	98.63	128.77	87.71	120.53	136.98	152.83	87.31
1993	106.65	96.57	124.66	97.31	75.34	70.25	75.25	68.53	187.98	230.53	162.34	67.65	73.12	180.94	144.60	67.34
1994	164.62	112.34	138.56	183.89	185.86	144.47	147.09	128.73	83.99	113.32	183.89	136.90	138.83	203.25	284.55	152.29
1995	90.34	71.12	169.24	186.93	173.72	129.61	124.06	101.90	132.25	152.43	211.19	138.57	105.86	242.30	274.73	145.70
1996	105.44	82.02	82.85	86.01	77.39	81.45	104.97	89.24	81.21	95.07	88.94	114.05	127.82	82.43	86.40	111.29
1997	79.15	65.05	123.36	124.01	110.35	82.39	99.67	79.61	106.54	132.82	156.80	92.36	70.32	152.26	154.77	101.74
1998	88.18	96.55	286.98	276.75	238.86	173.29	102.44	89.00	259.82	341.84	358.53	130.93	89.62	351.94	340.31	125.43
1999	139.11	99.00	127.75	125.33	115.45	103.74	152.23	127.93	120.21	160.59	172.32	145.08	108.27	175.47	172.89	151.81
2000	62.38	85.30	136.30	145.81	135.71	105.98	59.58	63.68	208.42	281.85	190.81	102.56	55.56	209.57	228.82	121.71
2001	72.23	76.08	155.85	147.78	126.74	92.72	79.01	77.90	152.13	210.32	211.58	88.89	107.49	234.79	233.53	97.52
2002	114.98	51.49	75.45	102.96	114.62	110.41	89.30	68.06	136.93	178.46	91.35	79.06	67.36	106.39	117.89	84.84
2003	117.71	90.50	103.99	119.81	120.20	105.16	86.56	79.27	121.35	159.76	104.44	95.69	115.79	107.81	126.08	107.35
2004	103.62	121.06	83.35	89.33	81.75	81.56	173.82	168.07	66.65	75.79	108.11	159.17	203.56	105.57	115.25	178.36
2005	89.85	96.29	201.14	180.57	149.14	106.87	87.89	93.58	242.33	301.02	249.03	81.35	119.85	256.45	215.21	85.14
2006	94.65	104.09	84.14	85.97	78.65	62.20	113.05	121.02	128.04	169.30	87.92	99.60	179.24	101.20	99.00	107.44
2007	71.27	61.80	69.35	56.46	55.79	53.03	63.84	65.04	105.38	94.65	65.31	52.66	70.72	58.10	51.39	49.36
2008	61.59	60.44	53.23	54.90	48.77	39.17	54.69	57.30	73.70	45.40	59.37	53.19	69.91	54.75	60.40	52.40
2009	70.42	79.43	42.26	51.84	57.63	59.64	59.85	66.37	74.06	71.60	51.18	65.74	79.40	55.04	68.29	64.96
2010	81.45	65.55	86.34	90.99	81.65	65.60	69.93	59.68	73.39	74.89	93.89	60.76	83.39	85.46	92.53	57.38

Con't																	
Grid No.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Longitude	38.63	38.88	38.88	38.88	39.13	39.13	39.13	39.38	39.63	39.63	39.63	39.63	39.63	39.63	39.63	39.88	40.13
Latitude	9.38	10.88	10.63	9.88	12.13	11.63	10.13	9.63	11.88	11.63	11.38	11.13	10.38	9.63	9.13	8.88	11.13
1983	91.47	112.58	112.49	52.41	169.28	206.33	82.08	66.78	168.85	186.61	175.62	135.87	111.03	71.98	72.03	67.26	58.23
1984	93.23	52.63	55.76	63.02	51.23	81.41	50.52	62.24	60.53	73.08	72.75	59.55	75.89	56.11	53.69	55.29	29.82
1985	108.61	88.23	96.17	93.62	44.15	72.19	92.69	76.25	69.42	89.85	93.60	80.68	103.73	61.90	61.68	53.10	62.38
1986	164.26	129.81	111.91	107.13	98.23	133.58	70.40	151.81	135.45	171.89	168.32	124.73	87.90	134.27	136.46	93.16	55.03
1987	100.13	102.41	121.44	53.78	71.93	82.67	91.20	64.47	79.29	94.46	95.98	82.26	151.97	69.42	68.56	79.03	38.66
1988	70.57	222.82	240.25	138.31	120.39	144.52	173.69	107.30	104.30	121.29	122.69	135.05	162.09	104.42	80.57	49.45	72.79
1989	65.57	79.72	76.17	46.77	144.23	183.66	59.75	95.46	135.08	142.05	127.34	90.95	84.73	94.04	86.48	60.41	42.51
1990	100.70	66.87	69.77	76.24	68.69	71.40	70.55	84.90	59.40	74.44	82.82	78.32	69.10	75.44	52.50	56.89	79.36
1991	104.47	69.15	72.50	72.38	80.34	108.00	76.51	113.61	79.81	90.08	83.31	87.33	143.86	110.60	106.89	68.19	62.18
1992	131.28	133.31	150.39	79.51	68.60	98.82	108.96	166.61	71.72	81.50	81.44	91.05	121.21	164.74	145.62	84.63	54.79
1993	98.38	180.44	151.44	76.53	162.63	219.81	110.41	113.81	157.08	172.44	175.46	166.13	132.70	111.22	90.93	63.64	71.20
1994	155.34	196.65	275.30	149.24	67.09	85.53	209.35	95.07	89.20	112.62	117.20	97.38	226.53	104.01	131.66	145.18	139.35
1995	185.59	262.56	289.36	146.61	178.72	219.66	227.09	152.69	206.41	232.96	251.80	262.93	267.94	131.18	129.06	92.20	112.69
1996	152.34	73.88	78.63	88.05	65.57	94.72	85.70	114.84	64.69	77.09	76.79	69.61	112.97	114.84	98.72	72.92	35.36
1997	139.49	109.75	115.23	103.12	77.34	116.55	100.56	141.43	109.54	132.18	128.44	98.34	123.74	124.92	102.83	80.37	60.33
1998	117.79	267.21	251.26	91.23	145.95	215.74	192.43	160.44	168.63	233.60	286.71	327.93	377.13	171.65	169.73	154.11	191.02
1999	160.75	137.18	137.19	148.17	172.67	123.76	141.28	138.11	124.05	122.56	138.61	135.69	131.83	116.62	78.73	64.59	81.19
2000	70.69	192.56	219.86	133.73	121.14	218.66	178.87	131.41	221.39	307.03	306.12	218.66	183.47	123.20	97.15	61.78	112.61
2001	112.97	225.46	247.01	102.16	137.93	177.84	176.67	171.39	192.36	248.77	242.35	173.11	249.52	169.12	127.38	104.45	97.41
2002	74.01	124.98	98.64	82.42	97.25	168.51	86.93	78.74	105.86	129.49	143.05	146.54	136.56	70.75	63.38	41.16	62.80
2003	124.24	94.48	102.00	114.83	84.16	96.20	97.38	164.52	76.72	107.40	110.57	86.24	93.23	151.50	123.41	85.76	48.87
2004	255.08	75.76	82.44	177.21	79.13	135.42	120.46	228.81	139.03	190.80	190.23	137.36	73.10	200.80	139.48	62.00	67.71
2005	89.12	223.41	176.69	113.73	190.47	294.79	171.74	139.56	197.70	236.88	230.28	177.91	221.49	135.93	152.42	122.95	84.72
2006	155.25	103.50	90.03	126.79	130.54	157.83	128.54	188.35	118.46	165.85	173.57	141.62	108.74	175.65	152.72	126.39	91.12
2007	63.29	57.20	47.81	42.80	115.80	92.39	48.86	54.77	89.41	86.35	77.90	64.73	52.53	54.85	68.86	66.56	51.29
2008	71.92	43.71	52.74	42.73	102.39	74.22	47.60	50.01	85.36	81.95	73.41	59.74	72.59	50.84	45.68	47.87	55.65
2009	54.28	53.82	65.61	62.67	128.36	68.41	59.71	73.03	82.46	100.45	105.48	86.84	53.42	66.41	45.11	36.43	58.88
2010	61.95	92.29	96.68	57.24	114.24	157.55	94.32	83.24	165.23	220.10	223.48	175.37	141.77	93.27	84.52	76.46	100.43

GLADS-3 day for 0.25 by 0.25 grid Size, year 1983-2010														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Lon	34.625	34.625	34.625	35.125	35.375	35.375	35.625	35.625	35.625	35.875	35.875	36.125	36.125	36.125
Lat	10.125	9.875	9.625	9.875	9.625	8.125	9.375	9.125	8.125	9.125	8.875	10.625	9.375	9.125
1983	147.1	136.3	125.5	123.1	122.8	168.1	137.5	126.3	172.8	123.2	126.1	93.6	132.6	120.1
1984	93.6	102.8	111.9	61.3	113.9	93.5	135.3	126.6	95.3	112.9	109.7	72.5	103.8	100.7
1985	52.1	44.6	57.3	44.4	51.9	59.8	58.0	57.1	52.6	65.3	69.1	82.7	88.8	93.6
1986	100.2	64.9	65.6	78.9	82.3	74.5	75.2	75.0	72.8	59.1	64.6	93.3	78.9	71.3
1987	96.4	97.3	127.8	92.8	140.6	113.9	185.9	179.7	119.4	195.8	190.7	133.2	215.9	211.9
1988	104.3	90.8	100.8	96.1	111.9	124.2	114.8	118.3	120.3	109.2	110.1	87.2	115.7	107.4
1989	113.0	95.1	126.2	105.6	154.1	98.7	139.2	100.5	108.7	100.0	114.3	142.3	113.2	115.7
1990	103.9	105.4	138.0	106.7	144.1	94.3	135.2	131.3	96.7	108.5	115.7	125.6	112.0	90.6
1991	85.6	107.9	146.2	141.2	217.2	89.3	203.8	155.5	86.6	111.1	81.9	93.4	108.3	85.8
1992	82.4	80.3	101.2	92.0	114.1	128.7	122.3	125.0	136.3	118.4	120.7	97.9	109.9	111.8
1993	116.7	107.1	98.8	116.3	134.8	85.6	117.6	109.9	89.1	96.8	94.9	79.8	120.6	116.1
1994	66.9	101.1	141.5	122.4	186.3	86.9	194.0	172.9	83.4	140.7	120.8	115.6	127.4	116.8
1995	81.0	67.6	94.7	61.9	102.9	107.9	113.1	116.8	102.3	83.4	86.0	86.1	119.2	112.9
1996	122.7	128.0	133.2	86.7	111.7	99.4	127.4	129.8	109.9	121.6	137.7	69.2	110.1	113.5
1997	192.2	192.7	193.3	183.3	172.6	107.7	178.3	138.4	107.8	137.5	122.7	131.7	154.2	141.9
1998	87.0	114.7	157.3	117.9	164.2	133.8	149.7	153.4	122.5	123.1	126.9	118.2	116.5	118.8
1999	93.9	84.2	80.5	82.2	100.8	76.5	107.0	109.1	90.1	108.4	109.1	126.0	108.5	107.7
2000	110.5	75.6	88.1	82.2	81.9	91.2	93.7	97.0	89.0	85.3	91.6	85.2	94.7	87.5
2001	149.2	133.7	187.2	195.5	316.9	177.4	307.7	246.1	166.7	179.3	137.6	167.9	138.5	112.5
2002	97.7	96.7	96.5	83.4	101.9	75.7	90.8	74.7	74.6	61.7	65.5	141.3	69.9	60.3
2003	88.4	80.4	97.9	92.9	144.2	122.6	170.1	165.4	115.8	150.3	144.0	113.8	143.0	135.2
2004	93.8	71.0	71.0	100.0	91.2	63.0	87.3	84.4	67.0	72.4	69.1	94.2	90.0	83.9
2005	98.7	102.8	134.1	160.5	229.8	116.4	229.8	214.1	114.0	162.8	151.5	169.5	134.3	119.3
2006	139.0	126.9	114.8	110.4	110.7	75.5	109.5	101.9	79.2	105.6	105.8	90.9	137.4	143.9
2007	76.5	88.6	100.8	66.2	73.7	110.6	89.8	96.1	106.2	93.4	97.9	62.5	88.2	90.7
2008	80.9	73.5	71.3	63.6	91.8	80.5	96.4	87.5	88.3	88.8	89.9	66.0	92.4	92.3
2009	63.4	75.1	105.1	59.5	116.6	60.4	136.2	114.0	56.0	104.2	82.0	38.6	116.7	94.5
2010	42.8	51.3	59.8	61.2	97.1	62.7	90.7	65.8	62.6	66.5	55.0	87.5	80.3	67.3

GLADS- 3 day for 0.25 by 0.25 grid Size, year 1983-2010																
Grid No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Longitude	34.625	34.625	34.625	35.125	35.375	35.375	35.625	35.625	35.625	35.875	35.875	36.125	36.125	36.125	36.125	36.125
Latitude	10.125	9.875	9.625	9.875	9.625	8.125	9.375	9.125	8.125	9.125	8.875	10.625	9.375	9.125	8.375	7.875
1983	147.1	136.3	125.5	123.1	122.8	168.1	137.5	126.3	172.8	123.2	126.1	93.6	132.6	120.1	112.5	88.3
1984	93.6	102.8	111.9	61.3	113.9	93.5	135.3	126.6	95.3	112.9	109.7	72.5	103.8	100.7	111.6	72.6
1985	52.1	44.6	57.3	44.4	51.9	59.8	58.0	57.1	52.6	65.3	69.1	82.7	88.8	93.6	143.3	101.2
1986	100.2	64.9	65.6	78.9	82.3	74.5	75.2	75.0	72.8	59.1	64.6	93.3	78.9	71.3	98.7	77.7
1987	96.4	97.3	127.8	92.8	140.6	113.9	185.9	179.7	119.4	195.8	190.7	133.2	215.9	211.9	184.9	121.4
1988	104.3	90.8	100.8	96.1	111.9	124.2	114.8	118.3	120.3	109.2	110.1	87.2	115.7	107.4	106.6	99.5
1989	113.0	95.1	126.2	105.6	154.1	98.7	139.2	100.5	108.7	100.0	114.3	142.3	113.2	115.7	125.9	102.1
1990	103.9	105.4	138.0	106.7	144.1	94.3	135.2	131.3	96.7	108.5	115.7	125.6	112.0	90.6	100.6	78.4
1991	85.6	107.9	146.2	141.2	217.2	89.3	203.8	155.5	86.6	111.1	81.9	93.4	108.3	85.8	113.7	77.1
1992	82.4	80.3	101.2	92.0	114.1	128.7	122.3	125.0	136.3	118.4	120.7	97.9	109.9	111.8	105.6	133.5
1993	116.7	107.1	98.8	116.3	134.8	85.6	117.6	109.9	89.1	96.8	94.9	79.8	120.6	116.1	103.3	93.6
1994	66.9	101.1	141.5	122.4	186.3	86.9	194.0	172.9	83.4	140.7	120.8	115.6	127.4	116.8	111.6	72.8
1995	81.0	67.6	94.7	61.9	102.9	107.9	113.1	116.8	102.3	83.4	86.0	86.1	119.2	112.9	85.0	53.2
1996	122.7	128.0	133.2	86.7	111.7	99.4	127.4	129.8	109.9	121.6	137.7	69.2	110.1	113.5	134.3	89.6
1997	192.2	192.7	193.3	183.3	172.6	107.7	178.3	138.4	107.8	137.5	122.7	131.7	154.2	141.9	97.9	132.9
1998	87.0	114.7	157.3	117.9	164.2	133.8	149.7	153.4	122.5	123.1	126.9	118.2	116.5	118.8	112.8	122.6
1999	93.9	84.2	80.5	82.2	100.8	76.5	107.0	109.1	90.1	108.4	109.1	126.0	108.5	107.7	109.1	122.7
2000	110.5	75.6	88.1	82.2	81.9	91.2	93.7	97.0	89.0	85.3	91.6	85.2	94.7	87.5	107.9	87.1
2001	149.2	133.7	187.2	195.5	316.9	177.4	307.7	246.1	166.7	179.3	137.6	167.9	138.5	112.5	134.4	96.6
2002	97.7	96.7	96.5	83.4	101.9	75.7	90.8	74.7	74.6	61.7	65.5	141.3	69.9	60.3	72.8	73.1
2003	88.4	80.4	97.9	92.9	144.2	122.6	170.1	165.4	115.8	150.3	144.0	113.8	143.0	135.2	108.8	81.3
2004	93.8	71.0	71.0	100.0	91.2	63.0	87.3	84.4	67.0	72.4	69.1	94.2	90.0	83.9	85.2	65.4
2005	98.7	102.8	134.1	160.5	229.8	116.4	229.8	214.1	114.0	162.8	151.5	169.5	134.3	119.3	83.5	97.6
2006	139.0	126.9	114.8	110.4	110.7	75.5	109.5	101.9	79.2	105.6	105.8	90.9	137.4	143.9	147.4	96.9
2007	76.5	88.6	100.8	66.2	73.7	110.6	89.8	96.1	106.2	93.4	97.9	62.5	88.2	90.7	89.2	83.2
2008	80.9	73.5	71.3	63.6	91.8	80.5	96.4	87.5	88.3	88.8	89.9	66.0	92.4	92.3	90.1	81.8
2009	63.4	75.1	105.1	59.5	116.6	60.4	136.2	114.0	56.0	104.2	82.0	38.6	116.7	94.5	79.2	59.0
2010	42.8	51.3	59.8	61.2	97.1	62.7	90.7	65.8	62.6	66.5	55.0	87.5	80.3	67.3	68.3	79.6

Con't																
Grid No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Longitude	36.125	36.375	36.375	36.375	36.375	36.375	36.375	36.375	36.375	36.625	36.625	36.625	36.625	36.625	36.625	36.875
Latitude	7.625	12.875	11.375	10.875	9.375	9.125	8.875	8.625	8.375	9.875	9.125	8.875	8.625	8.125	7.875	11.375
1983	91.2	68.2	105.3	93.4	130.2	117.0	104.1	129.5	126.3	142.6	117.1	108.4	132.0	94.9	104.1	130.3
1984	75.2	94.8	85.3	82.6	88.0	100.1	112.3	124.5	116.0	88.1	92.3	106.2	137.8	99.4	90.0	96.6
1985	81.5	72.5	148.1	92.8	113.8	121.9	134.8	180.1	188.0	83.5	129.4	155.4	200.0	172.1	138.6	160.7
1986	93.9	114.7	150.8	114.2	103.1	84.3	95.6	133.9	135.8	90.2	82.4	117.8	154.2	112.2	97.0	158.9
1987	126.1	74.2	98.9	112.6	231.0	227.9	224.9	221.9	204.6	174.7	220.9	218.1	215.4	171.5	143.1	76.7
1988	104.4	107.8	88.6	78.0	148.7	137.7	126.6	115.5	108.9	107.6	148.9	133.3	117.7	104.4	114.7	111.9
1989	90.2	91.0	148.1	153.0	132.9	131.4	130.0	128.6	124.1	105.9	144.0	138.1	132.2	118.7	111.7	152.2
1990	77.4	135.2	131.0	118.4	148.7	116.9	96.1	114.2	112.0	194.8	128.1	97.9	109.8	79.6	78.9	106.8
1991	65.1	108.7	187.8	113.5	143.5	116.4	138.7	160.9	152.6	121.6	136.6	160.4	184.1	122.5	99.8	128.5
1992	148.0	82.4	97.6	96.4	132.4	118.4	106.8	108.4	96.7	152.0	122.6	106.3	92.3	103.6	146.6	72.4
1993	108.7	111.6	139.2	101.7	164.6	159.6	154.5	149.4	135.6	122.9	180.1	174.8	169.5	128.4	102.8	115.9
1994	69.8	73.9	104.8	114.1	123.5	121.5	123.4	139.5	137.2	158.4	117.2	124.3	148.6	114.5	83.6	113.5
1995	63.0	131.1	112.0	94.0	164.4	155.4	146.4	137.4	116.3	114.3	162.5	152.5	142.4	85.9	58.6	125.0
1996	95.1	80.3	86.1	88.1	106.1	110.5	118.9	132.3	125.3	102.2	111.5	122.2	132.9	113.3	121.7	86.8
1997	177.6	128.7	139.5	145.4	156.2	146.3	136.5	126.6	107.3	123.0	132.5	123.9	115.4	82.2	121.7	99.4
1998	132.3	205.2	136.6	110.6	113.7	114.5	115.3	118.7	121.1	93.7	100.3	105.8	119.3	138.1	154.3	154.5
1999	129.5	146.3	234.0	160.2	109.2	107.0	104.8	102.6	110.6	110.0	105.9	102.3	101.0	131.1	153.8	204.4
2000	121.9	177.3	167.7	135.0	107.3	95.6	109.1	122.6	125.0	89.2	99.0	113.9	128.8	124.2	121.6	256.1
2001	122.5	101.5	119.6	171.4	193.9	146.6	123.8	173.4	179.3	193.2	153.4	122.2	171.1	141.6	105.7	129.6
2002	95.7	97.0	175.8	141.2	96.3	71.3	65.2	76.1	74.8	159.2	78.8	73.0	80.2	80.6	80.1	153.0
2003	76.6	185.7	112.7	108.0	132.8	122.8	112.9	102.9	94.1	134.4	138.7	124.3	109.9	77.8	96.6	98.2
2004	73.2	104.5	191.7	125.6	104.4	104.8	115.8	126.8	116.0	107.9	117.2	128.8	140.4	91.4	87.8	184.0
2005	115.9	95.0	147.5	154.0	168.6	152.3	136.1	119.8	100.2	111.5	157.0	142.8	128.5	99.7	116.8	156.3
2006	85.7	126.1	116.3	90.3	177.2	186.1	195.0	203.9	192.0	145.7	209.1	217.9	226.6	175.1	137.9	116.6
2007	91.5	86.6	94.8	70.8	87.4	88.0	88.6	89.3	84.4	72.6	78.9	78.8	78.6	68.4	68.8	87.7
2008	80.7	63.4	100.6	86.1	97.2	95.9	94.6	96.3	91.8	77.8	93.3	92.5	92.1	84.3	79.6	88.0
2009	60.1	84.4	61.5	45.9	107.0	84.7	86.0	111.9	109.8	82.1	82.3	87.8	114.7	80.8	69.6	76.1
2010	85.3	73.3	98.2	92.0	92.8	75.9	77.4	85.7	78.9	123.2	75.2	80.5	85.9	83.8	96.7	100.0

Con't																
Grid No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Longitude	36.875	36.875	36.875	36.875	36.875	36.875	36.875	36.875	37.125	37.125	37.125	37.125	37.125	37.125	37.125	37.125
Latitude	10.875	10.625	9.125	8.625	8.375	8.125	7.875	7.625	12.625	12.375	11.375	10.625	9.875	9.625	9.125	7.875
1983	103.1	138.8	120.2	108.4	100.3	77.2	83.0	101.8	96.2	95.9	137.0	138.2	138.4	131.2	123.4	127.0
1984	84.9	79.1	101.1	145.5	141.3	102.9	83.1	77.7	95.4	95.4	104.7	81.2	98.7	114.5	116.5	76.3
1985	112.5	154.6	131.3	196.2	195.8	162.5	129.1	95.8	133.4	122.0	155.1	174.8	113.2	112.4	151.7	119.7
1986	129.3	153.9	113.2	156.5	148.1	109.8	89.3	115.7	92.2	112.0	169.7	173.8	92.7	121.9	144.9	91.8
1987	73.4	72.4	190.8	184.3	170.5	146.2	131.7	133.3	121.2	116.2	83.4	102.0	127.3	153.4	160.7	129.6
1988	73.4	75.1	141.0	97.4	90.2	98.4	107.6	116.9	103.7	107.9	138.7	100.3	109.5	153.3	133.1	100.5
1989	122.6	144.3	153.4	139.6	130.8	120.3	109.7	99.1	123.9	124.4	150.5	119.4	133.9	165.7	162.9	107.7
1990	120.6	168.9	127.5	83.8	81.1	61.4	69.3	86.0	129.5	134.6	92.3	157.7	189.9	193.7	126.8	59.6
1991	113.6	110.5	143.6	184.7	170.6	121.8	92.5	93.1	112.1	104.1	119.2	106.7	112.9	143.9	150.7	85.2
1992	120.6	149.7	107.3	86.0	86.7	90.4	120.1	149.9	96.4	104.4	77.8	155.1	139.2	127.7	92.0	101.9
1993	94.7	104.6	177.9	167.5	152.3	127.3	102.3	113.3	164.9	171.3	109.9	89.2	130.0	162.1	175.6	101.7
1994	139.8	195.7	120.1	128.7	124.2	100.4	76.6	82.2	90.9	92.1	123.5	205.0	185.8	166.3	131.9	88.0
1995	101.4	106.6	134.4	115.4	96.8	69.1	46.9	61.0	114.1	97.7	123.0	131.6	84.5	108.0	106.3	47.7
1996	87.8	98.6	96.1	111.8	107.7	106.5	105.3	115.5	109.6	105.5	83.0	124.2	100.4	121.5	97.3	106.3
1997	104.4	119.7	100.5	83.6	78.5	70.0	94.3	118.7	122.9	113.0	78.9	136.7	72.5	99.9	75.6	85.2
1998	96.0	96.0	107.3	112.2	118.6	128.9	139.2	158.6	193.0	202.0	161.2	84.0	120.3	136.0	137.7	128.0
1999	157.6	148.7	104.4	96.0	102.2	122.5	142.9	163.3	175.7	204.1	210.9	155.6	91.7	105.5	102.9	132.0
2000	140.4	135.8	97.7	126.6	129.5	120.8	118.8	130.9	198.5	194.5	306.3	146.3	104.1	93.0	96.4	115.9
2001	172.0	232.4	125.1	122.2	129.3	108.7	94.6	122.4	157.5	163.6	171.3	208.3	126.3	156.8	113.7	91.0
2002	169.0	236.6	74.0	78.5	81.3	79.6	78.0	94.2	80.9	79.5	125.6	244.0	171.7	128.9	75.5	77.7
2003	115.8	124.7	135.3	94.4	87.0	78.1	109.0	139.8	242.0	224.1	126.0	161.1	169.9	171.1	131.9	121.3
2004	125.5	96.2	116.7	134.1	121.1	86.5	85.2	101.5	188.5	192.9	160.6	89.9	108.9	116.9	116.2	82.7
2005	105.2	115.8	133.3	115.2	101.3	99.3	110.8	122.3	93.0	111.3	148.1	121.9	119.3	129.6	128.0	114.2
2006	107.4	110.4	213.1	225.0	208.4	169.4	130.3	91.3	118.5	112.0	132.0	119.3	155.8	193.6	217.1	122.8
2007	90.0	93.9	63.5	64.0	61.6	56.4	67.6	79.9	86.5	82.7	114.8	105.5	75.0	71.9	56.0	66.4
2008	75.7	69.5	84.4	87.2	86.8	84.7	82.5	80.4	83.3	73.8	71.7	59.9	75.0	87.3	75.6	85.5
2009	55.4	46.3	76.1	88.8	87.1	76.7	69.0	75.1	79.3	89.2	82.2	50.5	64.8	80.1	69.9	73.4
2010	106.1	116.3	76.9	68.3	67.4	78.0	88.7	99.4	127.7	112.8	91.8	116.7	107.1	111.9	80.2	80.7

Con't																
Grid No.	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Longitude	37.125	37.375	37.375	37.375	37.375	37.375	37.375	37.375	37.375	37.625	37.625	37.625	37.625	37.625	37.875	37.875
Latitude	7.625	12.625	12.375	11.625	11.375	10.625	10.375	9.625	7.875	12.875	11.875	11.375	10.875	10.375	11.875	11.125
1983	125.3	99.7	99.3	146.7	143.6	137.7	152.1	128.27	177.78	64.504	100.5	128.69	101.3	134.87	75.088	85.08
1984	67.3	133.6	133.4	108.2	112.9	87.4	81.206	128.79	69.398	96.033	75.624	105.01	84.086	79.115	63.582	83.699
1985	86.5	154.5	142.9	154.3	149.4	195.1	202.04	139.77	110.21	126.59	117.43	136.96	141.21	187.05	94.025	127.43
1986	117.0	114.2	95.6	174.2	180.6	193.6	193.11	167.15	100.92	145.33	127.01	162.92	133.97	177.28	98.012	100.41
1987	130.1	144.5	137.1	94.5	112.5	140.4	126.96	151.02	127.51	119.4	71.504	120.12	144.49	142.79	62.615	121.16
1988	108.7	104.6	108.9	164.0	165.5	125.6	125.57	154.57	93.432	112.29	114.75	156.48	86.369	122.28	90.772	101.29
1989	93.6	123.3	124.7	149.7	148.8	94.4	98.988	197.36	105.71	90.078	106.41	132.58	116.43	96.128	130.01	128.63
1990	78.6	114.4	118.3	97.0	106.4	151.6	171.5	195.43	60.408	80.906	85.735	104.92	134.48	145.54	77.7	99.307
1991	90.6	102.2	95.6	122.2	119.8	102.8	95.889	137.45	92.48	81.166	82.776	110.78	87.583	86.166	75.894	92.487
1992	126.6	95.7	103.7	90.3	93.0	160.6	164.03	117.27	125.9	73.831	87.467	96.43	124.61	144.63	80.907	96.945
1993	108.3	165.4	170.9	100.1	108.4	93.6	97.426	159.91	101.11	113.19	102.62	94.127	85.51	100.97	97.06	119.15
1994	98.6	96.2	96.3	140.3	133.4	214.3	235.82	181.21	100.43	88.084	109.81	121.07	139.42	214.15	81.106	81.052
1995	57.5	116.3	106.8	108.6	121.0	156.5	152.42	90.112	48.549	111.21	93.983	122.33	122.23	154.39	114.97	139.79
1996	113.0	117.5	113.0	77.5	79.8	149.9	149.77	123.69	112.67	102.72	74.409	81.376	102.62	147.74	63.521	81.951
1997	104.7	146.4	133.2	84.9	105.1	153.6	142.93	110.99	76.038	144.9	76.316	107.85	132.88	134.02	79.15	97.569
1998	149.6	222.1	227.7	188.2	168.0	106.5	111.92	172.93	116.75	189.87	193.25	203.99	169.87	128.99	211.44	257.14
1999	149.9	218.4	248.2	239.7	217.4	162.4	142.1	117.62	121.07	149.87	224	201.95	148.94	128.65	161.71	137.24
2000	126.4	213.1	208.4	350.4	356.4	166.3	164.61	98.173	113.02	164.7	240.87	333.8	180.9	155.28	174.52	183.82
2001	111.8	164.7	172.6	207.9	213.0	184.1	187.71	154.21	87.343	123.77	165.85	227.13	133.33	153.28	164.4	173.67
2002	88.0	87.3	83.5	147.6	149.2	251.4	265.44	134.3	77.305	84.937	110.23	156.09	163.09	240.73	89.777	114.62
2003	151.3	251.9	234.9	128.2	153.8	197.5	201.36	180.76	133.67	209.56	116.58	152.73	184.45	201.9	129.14	138.34
2004	97.4	197.0	199.0	130.8	137.2	86.6	100.23	138.03	80.16	138.7	101.21	119.05	84.211	88.565	83.465	79.742
2005	124.9	116.8	133.3	156.1	139.9	137.9	133.89	146.38	117.66	94.22	133.74	118.83	127.68	130.59	124.58	171.41
2006	82.0	165.0	156.8	178.9	181.0	130.2	133.28	200.71	115.19	151.12	139.62	179.79	113.91	126.84	126.83	93.242
2007	80.6	82.3	78.7	149.4	149.8	117.0	114.75	84.143	65.238	77.276	126.28	155.51	100.34	106.78	120.27	105.14
2008	85.8	101.0	88.8	72.2	79.7	72.8	64.558	92.238	88.358	115.92	58.013	81.097	77.141	66.865	53.387	67.325
2009	69.2	87.3	95.4	93.9	88.3	56.1	48.535	100.5	77.734	94.504	88.293	84.588	65.054	45.308	69.902	63.426
2010	89.1	144.9	127.8	101.0	105.3	117.1	105.62	109.03	72.717	132.26	83.385	105.54	103.31	98.301	78.408	87.292

Con't																
Grid No.	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Longitude	37.875	37.875	38.125	38.125	38.125	38.125	38.125	38.125	38.375	38.375	38.375	38.375	38.375	38.625	38.625	38.625
Latitude	9.625	8.875	10.875	10.625	10.375	10.125	9.375	9.125	11.875	11.625	10.875	9.875	8.875	10.875	10.625	9.875
1983	92.931	139.12	86.4	82.852	72.968	68.27	88.561	104.48	159.35	173.76	107.96	82.119	106.82	112.54	110.85	80.85
1984	88.25	104.39	93.23	96.151	88.005	69.877	86.898	81.069	76.114	78.972	101.39	89.551	86.76	95.459	98.292	90.245
1985	102.07	121.15	122.86	129.95	118.54	88.622	104.46	96.915	65.923	83.523	113.68	76.278	91.674	101.1	124.17	77.53
1986	122.06	111.48	123	101.76	84.954	80.3	105.66	99.701	157.18	215.67	166.87	94.333	124.35	173.73	145.46	106.48
1987	96.163	116.05	127.38	144.76	136.12	101.47	107.95	115.7	80.515	110.33	118.83	75.26	130.86	100.52	118.93	74.097
1988	116.89	89.742	112.9	117.04	116.53	111.4	92.446	87.376	116.35	162.9	147	105.85	84.987	156.64	165.98	104.45
1989	163.45	142.46	130.51	128.25	115.9	93.438	137.72	129.84	224.55	267.86	137.53	104.23	109.09	125.12	127.66	93.732
1990	122.74	95.528	94.329	106.39	100.31	76.1	108.83	105.13	61.629	80.533	74.25	85.198	107.31	72.465	72.307	76.65
1991	94.2	122.53	83.395	70.606	57.577	53.712	79.434	87.269	94.452	112.72	85.236	58.316	130.23	80.488	66.356	63.964
1992	109.14	148.9	111.97	116.34	107.48	85.343	149.35	153.11	106.58	130.07	129.86	114.68	164.85	136.98	152.83	109.93
1993	107.57	119.55	137.9	115.83	94.086	78.535	96.578	91.368	187.98	230.53	166.75	84.456	97.494	180.94	144.6	93.755
1994	164.82	112.34	141.4	184.83	185.86	144.47	164.1	151.16	83.989	113.32	184.83	142.97	177.32	203.25	284.55	152.29
1995	114.95	87.443	185.93	202.45	187.1	139.86	148.22	133.01	156.96	154.14	229.89	159.5	148.16	263.95	295.89	164.85
1996	98.404	98.729	94.512	97.568	88.56	107.06	139.04	102.28	88.509	97.587	105.27	149.7	105.08	103.07	106.97	144.58
1997	80.078	68.079	137.59	143.93	130.27	96.619	79.946	60.155	94.867	132.82	173.69	76.073	71.789	168.2	177.1	82.372
1998	157.5	137.85	310.38	293.39	250.46	181.58	142.25	129.57	288.41	378.14	380.62	135.15	95.882	375.61	358	132.02
1999	143.19	109.69	133.33	133.68	120.41	104.8	157.5	138.14	120.21	160.59	172.32	145.66	127.86	175.47	172.89	153.05
2000	80.633	90.662	172.77	172.66	157.64	127.72	88.207	84.499	208.42	281.85	241.88	120.12	94.257	261.71	267.02	135.8
2001	104.49	67.13	183.38	181	157.36	112.47	96.524	98.379	165.17	224.05	248.1	91.871	140.33	274.2	283.94	108.3
2002	118.78	59.102	115.58	123.46	125.87	119.46	93.068	72.345	79.717	108.96	129.88	97.535	70.383	127.33	157.93	105.71
2003	120.68	103.31	123.35	138.6	136.39	116.73	100.04	99.068	154.25	180.49	114.22	86.026	133.81	107.81	105.85	90.816
2004	106.44	133.25	96.265	98.889	90.053	83.724	179.17	175.85	68.189	87.227	114.73	162.73	211.81	110.41	118.98	181.75
2005	103.07	96.292	210.71	193.96	163.71	119.93	102.6	93.583	242.33	301.02	252.22	87.958	119.85	256.45	215.21	111.11
2006	130.5	138.78	105.66	87.954	79.426	80.495	131.16	130.33	151.51	180.29	139.22	118.63	179.24	159.72	139.72	133.69
2007	72.818	58.2	79.17	77.685	71.148	70.461	70.266	62.869	122.25	104.8	73.793	73.239	61.676	69.121	71.526	70.689
2008	64.2	78.369	70.185	72.405	64.324	46.044	64.805	73.693	73.702	60.588	78.349	53.19	90.621	72.243	79.694	53.216
2009	70.416	79.425	46.576	51.839	57.629	59.642	61.11	66.372	81.955	80.685	51.182	65.742	79.401	55.037	68.291	64.959
2010	92.059	74.318	86.336	90.994	81.654	68.378	89.244	74.076	100.71	102.44	93.891	66.701	84.948	85.458	92.534	63.921

Con't																	
Grid No.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
Longitude	38.625	38.875	38.875	38.875	39.125	39.125	39.125	39.375	39.625	39.625	39.625	39.625	39.625	39.625	39.625	39.875	40.125
Latitude	9.375	10.875	10.625	9.875	12.125	11.625	10.125	9.625	11.875	11.625	11.375	11.125	10.375	9.625	9.125	8.875	11.125
1983	121.98	112.58	112.49	61.61	170.34	208.82	87.423	64.343	170.83	189.38	178.39	137.85	114.89	60.569	60.002	54.266	59.084
1984	120.46	75.433	73.483	81.6	65.397	84.245	49.928	84.092	61.015	73.237	72.749	65.233	75.928	76.477	60.79	55.981	28.327
1985	94.739	89.122	124.78	78.859	70.564	101.04	105.43	71.578	80.767	113.07	120.01	101.57	115.41	68.301	61.676	53.101	83.169
1986	164.26	143.6	131.21	107.13	111.11	140.18	92.356	151.81	150.48	176.9	168.32	124.73	110.74	134.27	136.46	93.156	55.026
1987	119.34	87.584	85.166	62.389	80.38	82.668	95.895	66.712	87.345	94.461	95.98	82.261	153.17	70.109	69.933	80.931	61.042
1988	109.37	145.13	153.98	102.07	174.81	129.4	119.6	130.73	139.06	121.56	123.25	115.67	131.5	131.89	99.414	64.033	72.793
1989	93.04	106.3	96.618	77.912	192.3	244.87	80.82	125.71	179.02	188.76	169.62	121.61	122.63	125.42	115.3	80.542	58.368
1990	100.7	75.86	72.771	76.677	70.547	77.923	71.76	85.237	57.102	79.937	88.119	81.631	71.235	76.464	76.272	62.435	86.616
1991	87.972	69.148	72.505	63.082	80.339	108	76.51	113.79	79.814	90.078	83.307	87.33	143.86	110.6	107.1	68.446	82.901
1992	159.56	133.31	150.39	89.785	92.53	95.616	110.68	226.75	89.123	87.106	93.735	104.41	148.93	224.66	203.34	125.78	64.117
1993	131.17	180.44	151.44	93.911	162.63	219.81	114.78	119.98	157.08	172.44	175.46	166.13	165.67	111.22	93.421	67.365	71.202
1994	208.12	196.65	275.3	149.24	75.6	105.39	209.35	168.38	94.543	106.93	102.54	94.573	226.53	186.57	174.61	156.57	104.51
1995	212.6	288.07	307.82	165.76	233.33	281.3	246.24	181.4	275.22	310.62	323.62	314.23	274.77	179.01	133.55	98.127	134.67
1996	199.11	113.06	128.44	113.21	78.117	104.57	119.4	139.18	78.135	91.423	94.661	117.85	203.64	129.36	120.32	83.44	56.041
1997	108.49	121.13	127.88	86.858	77.336	116.55	107.74	119.75	109.54	132.18	128.44	98.342	123.74	116.63	95.274	81.825	65.075
1998	144.97	295.34	276.35	122.02	163.47	245.5	192.43	187.41	169.4	233.86	286.71	327.93	377.13	188.11	189.57	162.61	191.02
1999	167.14	137.18	137.19	151.89	131.11	98.404	145	150.29	93.04	93.055	107.17	108.86	133.87	130.9	107.03	78.16	108.11
2000	95.997	232.23	248.54	144.83	191.43	277.49	189.8	135.74	320.42	389.73	386.79	311.6	186.26	126.58	99.354	75.149	182.89
2001	140.68	261.69	294.97	116.85	140.24	180.14	209.01	208.02	192.63	248.87	242.35	173.11	283.19	205.6	144.1	117.96	84.039
2002	78.265	126.37	134.41	103.61	98.815	157.3	114.02	88.267	141.14	172.65	169.71	132.31	104.89	81.284	54.044	39.317	70.215
2003	125.07	94.759	114.72	86.126	79.446	115.15	99.656	123.39	102.29	143.2	147.43	114.98	113.83	116.26	149.47	122.33	72.342
2004	260.88	83.336	90.098	179.63	64.621	135.42	121.44	229.45	139.03	190.8	190.43	137.93	85.866	200.8	150.22	74.774	70.569
2005	117.81	223.41	221.3	137.24	190.63	294.79	202.95	151.15	197.7	236.88	230.29	186.04	246.49	147.68	153.22	126.95	96.224
2006	161.66	167.15	155.99	145.55	130.54	161.68	135.3	210.6	118.46	165.85	173.59	156.34	158	218.03	202.91	165.6	91.444
2007	67.283	72.141	60.359	64.204	135.91	119.41	63.977	74.428	113.96	114.9	106.78	89.603	62.049	74.331	84.923	76.516	69.996
2008	71.925	53.694	60.439	52.134	107.49	94.961	54.613	66.649	98.177	99.889	92.192	75.084	72.802	67.5	59.653	54.313	60.091
2009	56.283	53.82	65.613	62.675	132.52	62.629	59.721	73.035	88.666	75.336	80.274	68.623	63.266	66.414	45.105	36.431	45.957
2010	82.017	76.663	96.684	66.419	162.57	119.46	99.706	83.238	142.95	174.04	172.47	135.25	143.36	93.336	84.516	76.455	100.43

APPENDIX C: Data Test Results for One Day Durations of in Situ Data.

Testing of independency											
Station	Statistic	Critical Test Statistics	Remark	Station	Statistic	Critical Test Statistics	Remark	Station	Statistic	Critical Test Statistics	Remark
1	0.77	1.96	Independent	36	0.34	1.96	Independent	71	0.90	1.96	Independent
2	1.20	1.96	Independent	37	0.47	1.96	Independent	72	0.07	1.96	Independent
3	1.24	1.96	Independent	38	0.78	1.96	Independent	73	2.02	1.96	dependent
4	0.04	1.96	Independent	39	1.26	1.96	Independent	74	1.02	1.96	Independent
5	1.08	1.96	Independent	40	0.14	1.96	Independent	75	1.26	1.96	Independent
6	0.00	1.96	Independent	41	3.49	1.96	dependent	76	0.27	1.96	Independent
7	1.55	1.96	Independent	42	0.26	1.96	Independent	77	0.93	1.96	Independent
8	1.80	1.96	Independent	43	0.48	1.96	Independent	78	2.99	1.96	dependent
9	0.64	1.96	Independent	44	0.50	1.96	Independent	79	0.27	1.96	Independent
10	1.16	1.96	Independent	45	2.64	1.96	dependent	80	0.68	1.96	Independent
11	0.38	1.96	Independent	46	2.04	1.96	dependent	81	0.55	1.96	Independent
12	0.73	1.96	Independent	47	0.59	1.96	Independent	82	0.08	1.96	Independent
13	1.08	1.96	Independent	48	0.82	1.96	Independent	83	0.12	1.96	Independent
14	0.22	1.96	Independent	49	0.77	1.96	Independent	84	0.74	1.96	Independent
15	1.33	1.96	Independent	50	3.00	1.96	dependent	85	0.78	1.96	Independent
16	0.94	1.96	Independent	51	0.19	1.96	Independent	86	0.46	1.96	Independent
17	0.06	1.96	Independent	52	1.05	1.96	Independent	87	1.00	1.96	Independent
18	1.81	1.96	Independent	53	1.40	1.96	Independent	88	1.20	1.96	Independent
19	1.89	1.96	Independent	54	0.70	1.96	Independent	89	0.66	1.96	Independent
20	0.30	1.96	Independent	55	1.29	1.96	Independent	90	1.35	1.96	Independent
21	2.00	1.96	dependent	56	0.47	1.96	Independent	91	0.16	1.96	Independent
22	1.04	1.96	Independent	57	0.75	1.96	Independent	92	0.93	1.96	Independent
23	0.29	1.96	Independent	58	0.20	1.96	Independent	93	1.32	1.96	Independent
24	1.72	1.96	Independent	59	0.96	1.96	Independent	94	0.58	1.96	Independent
25	0.63	1.96	Independent	60	0.19	1.96	Independent	95	0.29	1.96	Independent
26	0.39	1.96	Independent	61	1.77	1.96	Independent	96	0.65	1.96	Independent
27	1.17	1.96	Independent	62	0.65	1.96	Independent	97	0.43	1.96	Independent
28	0.43	1.96	Independent	63	0.83	1.96	Independent	98	1.84	1.96	Independent
29	0.29	1.96	Independent	64	2.80	1.96	dependent	99	1.32	1.96	Independent
30	0.06	1.96	Independent	65	0.25	1.96	Independent	100	1.14	1.96	Independent
31	0.82	1.96	Independent	66	0.07	1.96	Independent	101	0.73	1.96	Independent
32	0.62	1.96	Independent	67	1.54	1.96	Independent	102	0.30	1.96	Independent
33	3.50	1.96	dependent	68	1.80	1.96	Independent	103	1.10	1.96	Independent
34	1.19	1.96	Independent	69	0.18	1.96	Independent	104	1.51	1.96	Independent
35	0.39	1.96	Independent	70	0.78	1.96	Independent				

Testing of Homogeneity											
Station	Statistic	Critical Test Statistics	Remark	Station	Statistic	Critical Test Statistics	Remark	Station	Statistic	Critical Test Statistics	Remark
1	0.1451573	1.96	Homogeneous	36	1.2421428	1.96	Homogeneous	71	0.7600782	1.96	Homogeneous
2	1.2471165	1.96	Homogeneous	37	0.1560756	1.96	Homogeneous	72	1.5892544	1.96	Homogeneous
3	0.1612287	1.96	Homogeneous	38	0.2817754	1.96	Homogeneous	73	1.6329932	1.96	Homogeneous
4	1.5798566	1.96	Homogeneous	39	0.94447	1.96	Homogeneous	74	0.529824	1.96	Homogeneous
5	0.0962841	1.96	Homogeneous	40	1.75242	1.96	Homogeneous	75	0.7311262	1.96	Homogeneous
6	1.6503615	1.96	Homogeneous	41	0.0990842	1.96	Homogeneous	76	1.0550088	1.96	Homogeneous
7	0.5674364	1.96	Homogeneous	42	0.2646889	1.96	Homogeneous	77	0.0869048	1.96	Homogeneous
8	0.5714286	1.96	Homogeneous	43	0.7146714	1.96	Homogeneous	78	0.3024853	1.96	Homogeneous
9	0.2184871	1.96	Homogeneous	44	1.6547929	1.96	Homogeneous	79	0.6531973	1.96	Homogeneous
10	0.4354718	1.96	Homogeneous	45	0.8714073	1.96	Homogeneous	80	0.2910262	1.96	Homogeneous
11	0.7611204	1.96	Homogeneous	46	1.4290302	1.96	Homogeneous	81	1.529291	1.96	Homogeneous
12	1.4696938	1.96	Homogeneous	47	0.4938839	1.96	Homogeneous	82	0.4940149	1.96	Homogeneous
13	0.1632099	1.96	Homogeneous	48	1.5772391	1.96	Homogeneous	83	0.202822	1.96	Homogeneous
14	0.1028689	1.96	Homogeneous	49	1.0133091	1.96	Homogeneous	84	1.0600677	1.96	Homogeneous
15	1.6484512	1.96	Homogeneous	50	1.8692559	1.96	Homogeneous	85	1.7992391	1.96	Homogeneous
16	0.3606582	1.96	Homogeneous	51	0.3582862	1.96	Homogeneous	86	0.5243691	1.96	Homogeneous
17	0.0544033	1.96	Homogeneous	52	0.7765446	1.96	Homogeneous	87	1.5688734	1.96	Homogeneous
18	1.7500071	1.96	Homogeneous	53	1.6970452	1.96	Homogeneous	88	1.8656464	1.96	Homogeneous
19	0.9615259	1.96	Homogeneous	54	1.2068892	1.96	Homogeneous	89	1.5462544	1.96	Homogeneous
20	1.7852677	1.96	Homogeneous	55	0.6527097	1.96	Homogeneous	90	1.0682486	1.96	Homogeneous
21	0.5794434	1.96	Homogeneous	56	1.7364863	1.96	Homogeneous	91	0.7311262	1.96	Homogeneous
22	0.4382208	1.96	Homogeneous	57	0.1455785	1.96	Homogeneous	92	0.7856812	1.96	Homogeneous
23	0.7838492	1.96	Homogeneous	58	0.1230915	1.96	Homogeneous	93	0.9773756	1.96	Homogeneous
24	1.9592234	1.96	Homogeneous	59	0.1512285	1.96	Homogeneous	94	0.7616461	1.96	Homogeneous
25	1.0566113	1.96	Homogeneous	60	1.4937678	1.96	Homogeneous	95	0.811899	1.96	Homogeneous
26	1.1879575	1.96	Homogeneous	61	0.9613434	1.96	Homogeneous	96	0.5935257	1.96	Homogeneous
27	1.2658197	1.96	Homogeneous	62	0.6236276	1.96	Homogeneous	97	0.3774089	1.96	Homogeneous
28	1.4088539	1.96	Homogeneous	63	1.0028257	1.96	Homogeneous	98	1.864478	1.96	Homogeneous
29	0.7821434	1.96	Homogeneous	64	0.4806717	1.96	Homogeneous	99	0.4100507	1.96	Homogeneous
30	0.8214194	1.96	Homogeneous	65	1.174827	1.96	Homogeneous	100	1.6177444	1.96	Homogeneous
31	0.2470224	1.96	Homogeneous	66	1.6547929	1.96	Homogeneous	101	0.5786376	1.96	Homogeneous
32	1.0762382	1.96	Homogeneous	67	0.0832337	1.96	Homogeneous	102	1.5497297	1.96	Homogeneous
33	1.3229343	1.96	Homogeneous	68	1.6414267	1.96	Homogeneous	103	1.8583493	1.96	Homogeneous
34	1.1652723	1.96	Homogeneous	69	0.4230571	1.96	Homogeneous	104	0.0792699	1.96	Homogeneous
35	0.326742	1.96	Homogeneous	70	0.4867497	1.96	Homogeneous				

APPENDIX D: Mathematical Expressions for Statistical Distributions of Annual Maximum Series

Distribution name	Distribution function F(x)	Variate and parameter ranges
Normal distribution (N)	F(x) = $\frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2\sigma^2}(x-\mu)^2}$	$-\infty < x < \infty$ μ and σ are parameters
Two parameter Lognormal distribution (LN2)	F(x) = $\frac{1}{\sqrt{2\pi}\,ax}\exp\left\{-\frac{1}{2}\left(\frac{\log x - b}{a}\right)^2\right\}$	0 < x
Three parameter Lognormal distribution (LN3)	F(x) = $\frac{1}{\sqrt{2\pi}\,a(x-m)}\exp\left\{-\frac{1}{2}\left(\frac{\log(x-m)-b}{a}\right)^2\right\}$	m < x
Exponential distribution (EXP)	F(x) = $\frac{1}{a}\exp\left(-\frac{x-m}{a}\right)$	m < x (i.e. P-III with b = 1)
Two parameter Gamma distribution(Gam2)	F(x) = $\frac{(x/a)^{b-1}}{/a/\Gamma(b)}\exp(-\frac{x}{a})$	0 ≤ x if a > 0 x ≤ 0 if a < 0 (i.e. P-III with m = 0)
Pearson-III distribution (P-III)	F(x) = $\frac{\left(\frac{x-m}{a}\right)^{b-1}}{/a/\Gamma(b)}\exp\left\{-\frac{x-m}{a}\right\}$	m ≤ x if a > 0 x ≤ m if a < 0
Log Pearson-III distribution (LP-III) If x P-III and z = log x	F(x) = $\frac{\left(\frac{z-c}{a}\right)^{b-1}}{x/a/\Gamma(b)}\exp\left\{-\frac{z-c}{a}\right\}$	$c < z < \infty$ $e^c < x < \infty$ a > 0 $-\infty < z < c$ $0 < x < e^c$ a < 0
Generalized Extreme Value distribution (GEV)	F(x) = $\exp\left\{-\left[1-k\left(\frac{x-u}{\alpha}\right)\right]^{1/k}\right\}$	α > 0 u + $\frac{\alpha}{k}$ ≤ x ≤ ∞ if k < 0 $-\infty$ < x ≤ u+ $\frac{\alpha}{k}$ if k >0
Extreme value Type I distribution (EV1)	F(x) = $\exp\left\{-e^{-\left(\frac{x-u}{\alpha}\right)}\right\}$	$-\infty < x < \infty$ α > 0

Cont'd

Distribution name	Distribution function F(x)	Variate and parameter ranges
Five parameters Wake by distribution (WAK 5)	$x = m+\alpha\,[1-(1-F)^{b}]-c[1-(1-F)^{-d}$ where F = F(x)	Note It is analytically defined only in inverse form
Four parameters Wake by distribution(WAK 4)	$x = \frac{\alpha}{\beta}\left[1-(1-F)^{\beta}\right]-\frac{\gamma}{\delta}\left[1-(1-F)^{-\delta}\right]$	
Generalized Pareto distribution (GPar)	$x = \varepsilon+\frac{\alpha}{k}\left[1-(1-F)^{k}\right]$ $F = F(x) = 1-\left[1-\frac{k}{\alpha}(x-\varepsilon)\right]^{1/k}$	
Log-Logistic distribution (LLg)	$F(x) = \left\{1+\left[\left(\frac{x-a}{b}\right)\right]^{-1/c}\right\}^{-1}$	$x > a,\ c > 0,\ b > 0$
Generalized logistic distribution (GLg)	$F(x) = \left\{1+\left[1-\gamma\left(\frac{x-\alpha}{\beta}\right)\right]^{1/\gamma}\right\}^{-1},\ \gamma \neq 0$ $= \left\{1+\exp\left[-\frac{x-\alpha}{\beta}\right]\right\}^{-1},\ \gamma = 0$	$\gamma < 0,\ \alpha+\frac{\beta}{\gamma} \le x < \infty$ $\gamma > 0,\ -\infty < x < \alpha+\frac{\beta}{\gamma}$ $-\infty < x < \infty$

APPENDIX E: Estimated Rainfall Depths for in situ and Reanalysis Data for Different Return Periods

Station No.	Estimated Rainfall Depths of in situ 1-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	69.251	93.076	100.604	109.500	115.687	121.530	128.850	134.142	150.617
2	45.947	66.033	73.708	83.643	91.088	98.505	108.291	115.687	140.243
3	56.635	91.980	107.110	127.315	142.796	158.464	179.476	195.600	250.572
4	46.806	71.548	81.149	93.503	102.703	111.834	123.849	132.921	163.117
5	48.139	61.267	64.990	69.179	71.971	74.526	77.623	79.794	86.233
6	62.992	94.759	107.969	126.018	140.282	155.157	175.846	192.328	252.733
7	47.413	67.686	74.892	83.929	90.554	97.077	105.619	112.057	133.560
8	49.561	60.516	63.278	66.050	67.661	68.955	70.285	71.067	72.731
9	40.075	66.780	78.375	93.940	105.913	118.064	134.399	146.961	189.926
10	42.597	59.663	66.495	75.583	82.600	89.789	99.609	107.305	134.756
11	33.499	53.320	61.243	71.555	79.302	87.039	97.280	105.053	131.123
12	47.065	90.240	110.254	137.763	159.296	181.407	211.469	234.805	315.722
13	47.892	70.531	79.182	90.379	98.770	107.130	118.159	126.495	154.172
14	62.964	85.753	95.136	107.875	117.880	128.257	142.601	153.957	195.092
15	73.502	103.586	115.545	131.419	143.613	156.023	172.803	185.800	230.976
16	59.902	84.468	92.497	102.126	108.904	115.365	123.532	129.486	148.264
17	62.984	94.493	108.138	127.277	142.796	159.342	182.951	202.243	276.461
18	56.279	77.923	86.193	96.898	104.919	112.912	123.456	131.426	157.885
19	51.122	72.761	81.030	91.732	99.752	107.743	118.285	126.253	152.707
20	75.486	99.057	106.890	116.349	123.047	129.458	137.598	143.555	162.455
21	69.600	95.217	102.481	110.655	116.103	121.089	127.130	131.368	143.931
22	55.385	103.607	126.484	158.184	183.146	208.881	244.000	271.347	366.603
23	52.253	68.963	74.215	80.407	84.705	88.758	93.828	97.488	108.859
24	61.445	80.608	88.434	99.003	107.261	115.788	127.516	136.753	169.892
25	78.811	102.093	111.494	124.099	133.878	143.914	157.619	168.338	206.286
26	57.425	108.971	138.996	183.556	220.384	259.574	314.649	358.579	516.964
27	48.040	73.217	83.248	96.286	106.073	115.839	128.758	138.558	171.399
28	48.965	63.714	69.349	76.644	82.110	87.557	94.742	100.173	118.204
29	52.253	68.963	74.215	80.407	84.705	88.758	93.828	97.488	108.859
30	56.3216	70.9951	75.1564	79.8384	82.9592	85.8149	89.2754	91.7026	98.8990
31	57.882	72.016	76.682	82.195	85.968	89.448	93.646	96.547	104.724
32	59.665	111.524	130.611	154.660	172.278	189.563	212.051	228.866	284.010
33	39.650	65.595	77.414	93.557	106.136	119.012	136.468	149.986	196.692
34	52.216	70.710	78.468	89.127	97.597	106.472	118.883	128.824	165.636
35	49.135	61.159	65.168	69.933	73.213	76.254	79.944	82.509	89.817
36	41.295	65.237	81.884	107.982	130.355	154.721	189.688	218.049	322.732
37	63.958	87.568	97.706	111.849	123.257	135.363	152.545	166.512	219.703
38	52.049	71.893	81.767	96.940	110.391	125.873	150.027	171.582	270.018
39	67.608	96.490	105.794	116.883	124.649	132.023	141.309	148.055	169.214
40	58.759	77.313	83.106	89.915	94.629	99.067	104.607	108.600	120.970
41	67.039	93.231	104.185	119.206	131.120	143.583	160.979	174.886	226.202
42	66.111	124.080	152.471	192.249	223.824	256.549	301.433	336.529	459.511
43	49.264	72.560	83.397	98.310	109.994	121.999	138.330	151.014	195.024
44	77.316	123.849	142.736	167.460	186.120	204.810	229.626	248.509	312.084
45	45.297	75.067	86.847	102.117	113.556	124.955	140.014	151.424	189.592
46	52.146	61.887	65.421	69.848	73.060	76.173	80.151	83.063	92.175
47	55.394	79.099	88.157	99.882	108.667	117.421	128.970	137.698	166.678
48	61.177	83.289	90.952	100.373	107.141	113.687	122.087	128.291	148.262
49	55.508	83.328	93.965	107.571	117.658	127.637	140.728	150.586	183.264

Con'td									
50	77.533	103.839	111.430	119.689	124.895	129.372	134.357	137.532	145.284
51	58.252	81.551	91.562	105.532	116.805	128.771	145.763	159.579	212.235
52	46.653	60.723	65.186	70.329	73.763	76.865	80.518	82.981	89.629
53	50.336	62.662	66.158	70.091	72.713	75.112	78.019	80.058	86.103
54	52.050	66.182	71.006	76.939	81.214	85.368	90.730	94.720	107.758
55	36.053	41.481	43.642	46.451	48.559	50.663	53.445	55.556	62.628
56	47.962	69.202	79.272	93.221	104.204	115.526	130.974	143.002	184.894
57	70.341	90.817	96.624	103.157	107.512	111.497	116.326	119.713	129.755
58	66.673	96.896	109.185	125.735	138.630	151.915	170.134	184.446	235.526
59	58.927	80.277	90.113	104.478	116.596	129.961	149.799	166.655	236.578
60	51.454	68.216	73.426	79.539	83.763	87.736	92.688	96.253	107.279
61	51.959	73.659	81.414	91.068	98.075	104.903	113.727	120.286	141.609
62	46.417	64.413	71.290	80.191	86.860	93.506	102.274	108.900	130.900
63	55.657	84.825	96.468	111.938	123.866	136.077	152.738	165.786	212.251
64	54.815	64.471	68.169	72.962	76.558	80.146	84.886	88.474	100.415
65	92.841	130.513	145.408	165.112	180.198	195.508	216.140	232.067	287.085
66	41.031	53.531	57.385	61.889	64.993	67.905	71.526	74.128	82.146
67	51.804	67.358	72.461	78.591	82.912	87.034	92.251	96.058	108.079
68	59.733	95.307	113.292	138.767	159.147	180.378	209.638	232.608	313.560
69	58.861	79.603	87.529	97.788	105.475	113.135	123.240	130.877	156.235
70	72.034	95.157	105.216	119.367	130.875	143.173	160.774	175.197	230.988
71	58.254	82.391	90.740	100.996	108.359	115.478	124.608	131.349	153.035
72	60.832	82.950	90.951	100.961	108.255	115.381	124.618	131.501	153.957
73	59.653	80.329	88.264	98.564	106.303	114.032	124.256	132.004	157.860
74	45.974	58.662	62.540	67.057	70.159	73.062	76.664	79.246	87.174
75	33.046	38.645	40.392	42.385	43.702	44.882	46.257	47.175	49.609
76	68.074	120.801	143.759	174.607	198.354	222.466	254.898	279.850	365.240
77	64.975	92.015	101.683	113.723	122.461	130.978	141.986	150.170	176.776
78	36.865	55.238	61.858	70.127	76.144	82.019	89.624	95.288	113.743
79	57.251	76.514	83.874	93.401	100.541	107.654	117.038	124.131	147.680
80	70.649	95.490	104.937	117.129	126.239	135.292	147.202	156.177	185.816
81	48.234	66.914	74.052	83.291	90.214	97.112	106.213	113.091	135.927
82	61.959	87.442	97.576	111.017	121.364	131.943	146.359	157.633	197.704
83	51.169	83.196	97.921	118.099	133.861	150.022	171.964	188.978	247.874
84	48.664	53.925	55.962	58.621	60.631	62.647	65.328	67.372	74.260
85	71.544	105.495	117.513	132.418	143.201	153.685	167.204	177.234	209.742
86	63.052	78.138	82.416	87.230	90.438	93.374	96.932	99.428	106.826
87	61.374	85.888	95.254	107.379	116.464	125.516	137.459	146.485	176.453
88	74.216	122.226	140.802	164.675	182.438	200.056	223.225	240.710	298.860
89	61.761	82.687	90.459	100.342	107.618	114.758	124.015	130.890	152.989
90	50.956	66.559	71.401	77.087	81.023	84.730	89.360	92.702	103.083
91	34.713	57.169	65.858	77.024	85.333	93.574	104.411	112.589	139.788
92	52.071	67.035	71.790	77.438	81.386	85.134	89.853	93.285	104.078
93	62.771	88.487	98.511	111.652	121.624	131.666	145.079	155.343	190.217
94	56.600	76.304	83.833	93.579	100.882	108.158	117.758	125.013	149.102
95	54.828	73.915	81.208	90.648	97.723	104.771	114.070	121.098	144.432
96	52.099	69.372	75.062	81.775	86.364	90.590	95.683	99.198	109.080
97	73.753	86.088	89.918	94.274	97.145	99.709	102.691	104.676	109.910
98	86.056	119.887	132.426	148.346	160.051	171.525	186.381	197.399	232.726
99	57.493	97.769	116.570	142.474	162.787	183.671	212.096	234.183	310.872
100	63.704	88.313	96.706	106.954	114.276	121.331	130.347	136.984	158.231
101	40.151	64.850	75.731	90.413	101.751	113.288	128.838	140.822	181.939
102	44.837	82.976	99.546	121.794	138.910	156.282	179.640	197.604	259.053
103	46.018	62.133	67.972	75.282	80.611	85.820	92.574	97.609	114.043
104	49.038	82.438	96.933	116.387	131.350	146.534	166.945	182.641	236.317

Station No.	Estimated Rainfall Depths of in situ 2-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	108.567	138.709	147.076	155.966	161.440	166.054	171.074	174.199	181.524
2	79.144	100.201	106.867	114.541	119.660	124.277	129.710	133.369	143.223
3	96.977	126.453	137.202	150.711	160.543	170.098	182.346	191.340	219.649
4	85.250	115.756	126.563	139.900	149.435	158.559	170.050	178.339	203.594
5	73.791	87.616	91.380	95.332	97.738	99.745	101.904	103.233	106.286
6	86.375	118.664	129.614	142.765	151.916	160.473	170.967	178.337	199.728
7	78.014	95.275	100.283	105.750	109.207	112.189	115.518	117.647	122.871
9	71.996	96.703	105.542	116.517	124.410	132.003	141.621	148.602	170.104
10	64.342	81.884	87.202	93.163	97.035	100.450	104.365	106.935	113.539
12	95.024	126.884	138.029	151.675	161.353	170.553	182.050	190.279	214.999
13	80.675	98.287	103.105	108.179	111.276	113.866	116.661	118.385	122.367
14	88.146	117.093	127.888	141.646	151.801	161.787	174.765	184.427	215.623
15	82.525	105.953	113.953	123.601	130.342	136.670	144.461	149.956	166.027
16	106.350	137.261	148.634	163.010	173.531	183.806	197.048	206.826	237.921
17	78.500	104.557	113.423	124.094	131.535	138.505	147.071	153.099	170.662
18	97.362	126.858	135.088	143.862	149.281	153.861	158.860	161.982	169.339
19	78.941	95.967	100.450	105.066	107.819	110.078	112.461	113.898	117.092
20	113.234	148.683	161.924	178.818	191.299	203.585	219.566	231.477	270.003
21	107.315	134.908	144.673	156.717	165.322	173.552	183.911	191.378	214.104
22	87.982	136.095	153.085	174.010	188.939	203.201	221.126	234.031	273.207
23	80.626	97.085	102.427	108.671	112.899	116.764	121.379	124.535	133.266
24	93.157	115.761	122.417	129.746	134.423	138.486	143.064	146.016	153.374
25	94.757	113.438	119.836	127.567	132.978	138.065	144.339	148.773	161.780
26	117.818	143.740	148.669	152.868	154.934	156.375	157.640	158.270	159.295
27	79.033	101.199	107.492	114.271	118.502	122.110	126.088	128.598	134.620
28	76.288	91.793	96.684	102.302	106.041	109.409	113.361	116.018	123.146
29	85.322	107.786	115.261	124.132	130.233	135.882	142.729	147.482	160.993
30	85.584	108.894	116.721	126.063	132.523	138.533	145.858	150.972	165.652
31	83.975	101.295	106.086	111.166	114.288	116.914	119.766	121.538	125.676
32	124.922	202.658	230.066	263.791	287.827	310.772	339.582	360.304	423.102
33	82.488	99.962	103.914	107.636	109.664	111.206	112.697	113.519	115.092
34	71.788	92.826	100.793	111.048	118.690	126.268	136.211	143.685	168.245
35	73.785	87.623	92.053	97.189	100.637	103.767	107.473	109.987	116.838
36	81.738	91.390	92.807	93.851	94.294	94.567	94.775	94.864	94.980
37	81.436	100.342	105.417	110.703	113.893	116.537	119.357	121.078	124.977
38	72.816	94.434	102.114	111.608	118.407	124.923	133.143	139.082	157.234
39	78.616	98.739	104.803	111.576	115.959	119.813	124.215	127.093	134.445
40	89.692	106.095	110.436	114.920	117.603	119.810	122.146	123.559	126.716
41	88.561	115.176	124.534	136.030	144.210	152.007	161.781	168.799	190.005
42	134.513	159.334	163.850	167.604	169.405	170.635	171.688	172.200	173.000
43	81.885	106.877	115.779	126.803	134.709	142.298	151.886	158.825	180.097
44	134.753	186.567	204.354	225.878	240.967	255.169	272.713	285.127	321.646
45	113.183	145.492	156.252	169.032	177.825	185.970	195.850	202.712	222.239

Con'td									
46	85.773	97.444	100.004	102.373	103.640	104.589	105.491	105.979	106.887
47	88.269	109.351	116.592	125.359	131.508	137.297	144.452	149.516	164.426
48	103.774	133.006	143.501	156.562	165.977	175.051	186.573	194.952	220.869
49	92.351	124.593	136.709	152.225	163.731	175.093	189.929	201.025	237.167
51	85.799	108.221	114.766	121.937	126.489	130.427	134.840	137.672	144.666
52	67.033	84.406	89.575	95.303	98.982	102.195	105.837	108.201	114.157
53	73.634	85.278	88.617	92.235	94.507	96.454	98.613	99.984	103.306
54	85.869	110.004	118.339	128.462	135.585	142.311	150.650	156.572	174.109
56	82.202	101.166	107.101	113.885	118.379	122.409	127.117	130.267	138.644
57	96.235	115.286	120.177	125.138	128.052	130.413	132.868	134.326	137.485
58	100.098	140.155	154.570	172.537	185.506	198.022	213.936	225.526	261.470
59	82.038	103.666	110.552	118.505	123.828	128.644	134.329	138.172	148.581
60	77.711	96.859	102.660	109.160	113.380	117.101	121.364	124.161	131.345
62	75.435	95.775	102.766	111.233	117.173	122.767	129.684	134.582	149.011
63	91.753	108.806	113.219	117.716	120.370	122.529	124.784	126.130	129.068
65	129.119	175.497	191.825	211.899	226.194	239.830	256.936	269.229	306.424
66	61.046	70.342	72.718	75.122	76.531	77.669	78.850	79.550	81.059
67	77.807	99.146	106.283	114.781	120.644	126.086	132.704	137.313	150.488
68	104.730	133.220	141.543	150.665	156.458	161.471	167.093	170.701	179.620
69	98.201	127.349	135.818	145.068	150.924	155.976	161.624	165.236	174.115
70	103.605	137.819	150.239	165.804	177.100	188.051	202.050	212.300	244.400
71	97.206	115.339	120.233	125.346	128.441	131.013	133.765	135.450	139.286
72	96.102	119.354	126.733	135.237	140.917	146.047	152.091	156.167	167.171
73	80.649	94.459	98.143	101.965	104.263	106.161	108.179	109.405	112.166
74	71.825	89.280	94.829	101.231	105.512	109.382	113.946	117.028	125.362
77	106.694	148.924	164.884	185.400	200.667	215.790	235.607	250.482	299.251
78	68.082	85.201	89.183	92.994	95.104	96.731	98.329	99.225	100.986
79	86.160	103.507	108.704	114.488	118.219	121.489	125.212	127.637	133.796
80	89.299	119.968	130.360	142.834	151.509	159.619	169.558	176.535	196.767
81	80.026	104.953	113.766	124.629	132.385	139.800	149.125	155.844	176.270
82	94.306	120.195	129.364	140.679	148.767	156.506	166.251	173.279	194.688
83	93.412	119.928	127.830	136.597	142.233	147.161	152.752	156.384	165.554
85	116.469	151.417	164.368	180.811	192.899	204.748	220.087	231.463	267.934
86	111.020	135.626	142.065	148.670	152.595	155.806	159.181	161.209	165.686
87	93.422	119.081	128.667	140.898	149.936	158.832	170.406	179.032	206.940
88	148.008	174.863	179.056	182.255	183.660	184.551	185.254	185.566	185.994
89	80.824	104.495	111.135	118.236	122.636	126.364	130.447	133.003	139.063
90	86.172	110.430	118.974	129.481	136.965	144.105	153.065	159.505	179.002
91	57.123	63.847	65.624	67.459	68.556	69.458	70.411	70.988	72.275
92	79.234	98.175	103.706	109.768	113.616	116.946	120.679	123.074	128.994
94	99.203	121.216	127.470	134.208	138.415	142.004	145.962	148.460	154.458
95	88.821	113.033	121.172	130.894	137.622	143.885	151.524	156.861	172.201
96	75.356	95.095	100.843	107.131	111.117	114.560	118.415	120.883	126.967
97	96.305	101.389	101.955	102.314	102.444	102.515	102.562	102.579	102.596
98	107.315	134.908	144.673	156.717	165.322	173.552	183.911	191.378	214.104
99	83.260	97.327	100.406	103.249	104.768	105.904	106.981	107.564	108.645
100	81.851	100.012	104.834	109.824	112.816	115.281	117.895	119.480	123.030
102	88.230	125.211	137.555	152.236	162.352	171.734	183.128	191.054	213.662
103	75.403	99.556	107.805	117.754	124.707	131.233	139.270	144.938	161.518
104	92.129	115.994	124.079	133.782	140.529	146.836	154.564	159.988	175.713

Station No.	Estimated Rainfall Depths of in situ 3-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	128.01313	171.32652	185.88419	203.27068	215.30127	226.4996	240.15681	249.69653	277.11283
2	99.610636	120.78396	126.56066	132.636	136.33792	139.43098	142.76262	144.81499	149.54229
3	118.74175	151.38585	162.19962	174.99919	183.77707	191.88577	201.68853	208.47566	227.67339
4	97.540807	132.43811	145.70791	162.83148	175.62425	188.33726	205.05928	217.65947	259.26137
5	96.209123	120.58775	128.11048	136.63444	142.23129	147.21361	152.98552	156.81362	166.84232
6	106.60495	144.62751	157.43279	172.74558	183.35448	193.23998	205.31087	213.75293	238.0687
7	91.816049	117.03331	126.22608	137.77672	146.18176	154.34856	164.81476	172.49848	196.67595
9	86.361495	116.86193	128.10276	142.32427	152.74349	162.92638	176.0643	185.77457	216.70961
10	75.610383	101.55485	110.85544	122.41911	130.74634	138.7658	148.93796	156.32923	179.15046
12	121.11379	139.89737	143.50419	146.59451	148.12392	149.19626	150.14186	150.61615	151.39433
13	96.250845	123.93293	132.99383	143.63954	150.88672	157.53955	165.52435	171.01267	186.33496
14	110.42409	138.47631	147.37496	157.63006	164.47828	170.66276	177.94674	182.85902	196.11492
15	90.527207	116.31803	125.36311	136.45584	144.33603	151.83742	161.22576	167.95638	188.23352
16	133.98317	170.901	182.93958	197.05097	206.63527	215.41624	225.93137	233.14241	253.19187
17	90.706325	124.28295	136.8271	152.83443	164.66203	176.30552	191.4545	202.74553	239.27867
18	123.14511	157.59474	165.9108	174.04376	178.64915	182.26581	185.89461	187.97381	192.20984
19	96.056451	113.63715	117.60961	121.34723	123.3823	124.92848	126.42235	127.24577	128.819
20	140.23434	175.39346	186.88673	200.37938	209.5573	217.97676	228.07394	235.0087	254.34166
21	126.82719	162.28754	174.7114	189.93828	200.74865	211.03392	223.89856	233.11575	260.85311
22	111.72257	156.84667	169.72137	183.63117	192.33922	199.7837	208.01605	213.22471	225.78883
23	96.285233	109.93412	113.44515	117.01033	119.10725	120.80764	122.57747	123.6303	125.91495
24	108.798	134.97692	143.82858	154.43971	161.80928	168.6907	177.11366	183.01875	200.10185
25	114.20823	131.26923	135.73022	140.30417	143.02087	145.24216	147.57617	148.9781	152.07069
26	131.85947	164.62047	172.53466	180.27793	184.66456	188.11068	191.56982	193.55267	197.59528
27	90.53235	118.69121	127.07623	136.37303	142.34613	147.56617	153.48647	157.32958	167.02396
28	94.33888	113.67611	119.76415	126.74782	131.38994	135.56571	140.46169	143.74849	152.54629
29	102.53748	126.21856	133.79342	142.56776	148.45713	153.79884	160.12176	164.40748	176.07702
30	101.35764	121.81764	127.58735	133.77711	137.62479	140.89448	144.48538	146.74152	152.11807
31	104.70431	126.14101	132.12255	138.49883	142.43718	145.76584	149.39882	151.66704	157.0136
32	153.57724	250.51012	284.82771	327.16328	357.41466	386.35595	422.78675	449.05596	529.0361
33	100.51791	129.77637	139.49377	151.01413	158.92737	166.24728	175.11037	181.25659	198.69095
34	90.420262	115.00437	123.35284	133.38769	140.37567	146.91563	154.9417	160.58341	176.98267
35	89.649018	107.0001	112.76855	119.61149	124.31474	128.66762	133.94135	137.60071	147.99219
36	96.612151	108.31378	110.35336	112.00791	112.78206	113.29991	113.73283	113.93826	114.24726
37	101.25222	118.45209	122.56014	126.55272	128.7993	130.55415	132.30419	133.30066	135.30973
38	91.152258	124.2775	136.7725	152.8143	164.73873	176.53794	191.98091	203.55957	241.43737
39	91.332507	110.63944	115.83778	121.26179	124.54062	127.26177	130.17026	131.94792	135.98759
40	107.40736	132.05311	139.40309	147.55975	152.80514	157.39279	162.60053	165.98414	174.53302
41	115.13021	153.1071	166.44469	182.81604	194.45626	205.54518	219.43538	229.40203	259.47543
42	155.59507	184.72326	191.01499	196.78201	199.83969	202.11138	204.25093	205.39967	207.50215
43	100.38851	130.09837	140.41182	152.97947	161.85102	170.25059	180.69763	188.14046	210.30894
44	158.31509	216.39879	236.29879	260.35067	277.19161	293.02651	312.56448	326.37267	366.90511
45	145.72598	196.69845	214.75835	237.04851	252.98382	268.23523	287.44247	301.29881	343.52267

Con'td									
46	102.469	125.099	131.324	137.904	141.933	145.314	148.973	151.239	156.501
47	110.333	131.736	138.465	146.176	151.297	155.901	161.293	164.910	174.576
48	132.083	168.545	181.329	197.003	208.136	218.732	231.990	241.494	270.114
49	111.967	148.990	163.007	181.043	194.481	207.804	225.281	238.415	281.558
51	106.677	134.040	142.040	150.811	156.384	161.208	166.620	170.095	178.692
52	85.845	107.398	113.859	121.054	125.695	129.766	134.401	137.423	145.100
53	87.980	108.626	116.474	126.598	134.160	141.674	151.555	158.998	183.564
54	104.647	135.042	145.802	159.073	168.556	177.626	189.044	197.275	222.333
56	96.925	120.307	128.331	138.039	144.843	151.246	159.154	164.749	181.200
57	119.403	139.473	144.106	148.520	150.954	152.822	154.650	155.670	157.660
58	123.783	174.330	193.247	217.415	235.292	252.907	275.851	292.971	348.475
59	96.586	127.885	139.750	155.032	166.426	177.732	192.574	203.737	240.463
60	91.962	113.876	120.661	128.366	133.435	137.956	143.204	146.692	155.863
62	88.408	107.847	113.784	120.469	124.831	128.694	133.141	136.072	143.668
63	115.432	147.334	157.498	169.242	177.105	184.223	192.628	198.311	213.719
65	153.623	203.045	220.565	242.197	257.666	272.476	291.132	304.596	345.648
66	78.723	96.045	101.525	107.831	112.035	115.826	120.285	123.286	131.364
67	96.187	122.349	131.149	141.666	148.946	155.726	164.000	169.782	186.415
68	131.179	144.012	145.512	146.491	146.856	147.058	147.194	147.246	147.302
69	123.136	154.379	163.982	174.837	181.946	188.262	195.562	200.391	212.990
70	124.315	166.672	182.287	202.047	216.527	230.681	248.945	262.447	305.476
71	123.514	146.348	152.026	157.678	160.935	163.532	166.182	167.728	170.970
72	113.425	142.038	151.296	162.097	169.397	176.059	183.999	189.418	204.359
73	100.300	120.195	125.723	131.602	135.225	138.280	141.606	143.678	148.541
74	92.492	111.981	117.641	123.821	127.732	131.106	134.876	137.286	143.209
77	134.653	185.441	202.514	222.907	237.019	250.157	266.180	277.375	309.552
78	85.178	97.585	99.560	101.083	101.759	102.192	102.536	102.692	102.907
79	100.731	120.148	126.399	133.670	138.570	143.029	148.328	151.934	161.822
80	102.972	138.841	152.317	169.573	182.369	195.003	211.497	223.833	264.004
81	99.086	132.143	144.221	159.419	170.495	181.269	195.097	205.263	237.335
82	114.912	138.355	145.069	152.340	156.902	160.810	165.141	167.888	174.539
83	107.979	139.975	150.879	164.013	173.179	181.772	192.341	199.786	221.510
85	141.282	179.905	193.373	209.829	221.477	232.531	246.317	256.165	285.642
86	138.537	178.914	190.999	204.439	213.101	220.691	229.326	234.948	249.206
87	117.752	144.824	154.409	166.236	174.687	182.773	192.952	200.292	222.644
88	165.728	216.078	229.485	243.380	251.723	258.609	265.920	270.359	280.333
89	90.755	121.723	132.214	144.804	153.559	161.742	171.770	178.808	199.211
90	103.650	133.011	143.407	156.233	165.399	174.169	185.208	193.169	217.411
91	79.747	83.732	84.236	84.579	84.712	84.789	84.843	84.865	84.889
92	93.592	116.264	122.949	130.317	135.023	139.115	143.729	146.706	154.140
94	122.308	141.529	146.094	150.516	152.996	154.927	156.847	157.937	160.122
95	107.556	138.906	150.003	163.692	173.473	182.830	194.607	203.099	228.949
96	91.666	108.857	112.821	116.595	118.674	120.270	121.830	122.700	124.394
97	116.422	128.992	131.062	132.689	133.426	133.906	134.295	134.473	134.729
98	126.827	162.288	174.711	189.938	200.749	211.034	223.899	233.116	260.853
99	99.145	117.098	121.240	125.185	127.360	129.030	130.662	131.573	133.349
100	98.815	119.799	125.163	130.590	133.770	136.340	139.006	140.586	143.993
102	110.122	152.316	166.200	182.567	193.745	204.035	216.424	224.968	248.958
103	90.554	120.512	131.867	146.489	157.391	168.205	182.402	193.077	228.193
104	119.400	139.505	144.650	149.858	152.912	155.381	157.944	159.464	162.745

Station No.	Estimated Rainfall Depths of ECMWF 1-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	83.089	120.587	133.804	150.064	161.651	172.710	186.594	196.578	226.825
2	62.472	81.070	87.502	95.322	100.830	106.034	112.492	117.083	130.701
3	70.315	103.605	115.400	129.957	140.364	150.325	162.868	171.917	199.491
4	64.624	80.187	84.327	88.616	91.189	93.312	95.564	96.931	100.000
5	57.419	82.192	90.914	101.638	109.275	116.560	125.699	132.267	152.142
6	44.428	55.058	58.685	63.056	66.109	68.973	72.497	74.981	82.239
7	64.811	84.036	91.145	100.158	106.775	113.253	121.628	127.831	147.667
8	74.054	99.724	108.158	118.092	124.870	131.105	138.605	143.772	158.259
9	73.276	87.050	89.226	90.896	91.635	92.106	92.479	92.647	92.878
10	51.693	66.549	72.184	79.446	84.863	90.239	97.301	102.615	120.111
11	51.693	66.549	72.184	79.446	84.863	90.239	97.301	102.615	120.111
12	75.785	100.207	108.544	118.597	125.620	132.211	140.325	146.047	162.774
13	71.871	97.398	106.010	116.320	123.471	130.140	138.293	144.001	160.473
14	68.553	95.706	105.151	116.674	124.819	132.539	142.152	149.009	169.479
15	72.341	112.710	128.069	147.896	162.713	177.442	196.822	211.430	259.693
16	61.995	83.797	90.644	98.487	103.693	108.369	113.845	117.515	127.313
17	66.498	82.454	87.938	94.582	99.243	103.633	109.061	112.906	124.232
18	75.534	96.509	100.885	104.815	106.857	108.348	109.725	110.450	111.733
19	71.871	97.398	106.010	116.320	123.471	130.140	138.293	144.001	160.473
20	64.624	80.187	84.327	88.616	91.189	93.312	95.564	96.931	100.000
21	64.624	80.187	84.327	88.616	91.189	93.312	95.564	96.931	100.000
22	72.341	112.710	128.069	147.896	162.713	177.442	196.822	211.430	259.693
23	55.188	73.264	79.512	87.106	92.452	97.502	103.766	108.217	121.412
24	66.073	92.807	101.801	112.549	119.990	126.921	135.378	141.289	158.294
25	71.907	94.369	101.839	110.702	116.795	122.435	129.269	134.012	147.485
26	65.060	77.979	81.469	85.118	87.328	89.165	91.133	92.338	95.086
27	75.534	96.509	100.885	104.815	106.857	108.348	109.725	110.450	111.733
28	61.576	94.930	107.551	123.786	135.878	147.862	163.578	175.383	214.142
29	70.315	103.605	115.400	129.957	140.364	150.325	162.868	171.917	199.491
30	74.225	89.476	92.199	94.439	95.502	96.221	96.830	97.124	97.574
31	70.320	87.472	92.408	97.769	101.142	104.039	107.258	109.306	114.289
32	67.901	94.712	103.677	114.352	121.715	128.550	136.861	142.648	159.188
33	66.073	92.807	101.801	112.549	119.990	126.921	135.378	141.289	158.294
34	40.704	51.956	56.248	61.798	65.952	70.087	75.536	79.651	93.282
35	62.108	79.190	84.954	91.856	96.644	101.111	106.571	110.395	121.434
36	62.108	79.190	84.954	91.856	96.644	101.111	106.571	110.395	121.434
37	67.901	94.712	103.677	114.352	121.715	128.550	136.861	142.648	159.188
38	62.876	76.105	80.230	84.933	88.040	90.822	94.063	96.227	101.958
39	82.777	116.812	129.581	145.919	158.022	169.964	185.541	197.181	235.026
40	66.073	92.807	101.801	112.549	119.990	126.921	135.378	141.289	158.294
41	62.472	81.070	87.502	95.322	100.830	106.034	112.492	117.083	130.701
42	70.429	93.178	99.527	106.295	110.477	114.011	117.869	120.278	125.957
43	62.108	79.190	84.954	91.856	96.644	101.111	106.571	110.395	121.434
44	76.676	115.416	129.141	146.080	158.190	169.778	184.373	194.901	226.979
45	59.234	74.425	79.296	84.948	88.748	92.199	96.290	99.068	106.651
46	55.188	73.264	79.512	87.106	92.452	97.502	103.766	108.217	121.412
47	76.676	115.416	129.141	146.080	158.190	169.778	184.373	194.901	226.979
48	68.073	76.656	78.518	80.229	81.139	81.817	82.457	82.801	83.434
49	62.876	76.105	80.230	84.933	88.040	90.822	94.063	96.227	101.958
50	62.627	74.332	77.360	80.444	82.264	83.745	85.290	86.212	88.225
51	61.444	74.040	77.847	82.105	84.865	87.296	90.077	91.898	96.564
52	62.472	81.070	87.502	95.322	100.830	106.034	112.492	117.083	130.701

Con'td									
53	66.498	82.454	87.938	94.582	99.243	103.633	109.061	112.906	124.232
54	61.576	94.930	107.551	123.786	135.878	147.862	163.578	175.383	214.142
55	61.444	74.040	77.847	82.105	84.865	87.296	90.077	91.898	96.564
56	57.419	82.192	90.914	101.638	109.275	116.560	125.699	132.267	152.142
57	65.293	82.386	88.702	96.705	102.578	108.326	115.754	121.253	138.822
58	83.089	120.587	133.804	150.064	161.651	172.710	186.594	196.578	226.825
59	62.472	81.070	87.502	95.322	100.830	106.034	112.492	117.083	130.701
60	73.276	87.050	89.226	90.896	91.635	92.106	92.479	92.647	92.878
61	73.276	87.050	89.226	90.896	91.635	92.106	92.479	92.647	92.878
62	73.276	87.050	89.226	90.896	91.635	92.106	92.479	92.647	92.878
63	58.438	74.316	79.718	86.217	90.748	94.993	100.208	103.877	114.564
64	74.600	99.643	105.610	111.400	114.653	117.191	119.718	121.155	124.044
65	67.419	87.308	92.565	97.991	101.234	103.901	106.720	108.425	112.227
66	57.651	74.479	80.225	87.156	91.999	96.545	102.142	106.091	117.638
67	55.188	73.264	79.512	87.106	92.452	97.502	103.766	108.217	121.412
68	57.651	74.479	80.225	87.156	91.999	96.545	102.142	106.091	117.638
69	74.225	89.476	92.199	94.439	95.502	96.221	96.830	97.124	97.574
70	61.995	83.797	90.644	98.487	103.693	108.369	113.845	117.515	127.313
71	44.428	55.058	58.685	63.056	66.109	68.973	72.497	74.981	82.239
72	55.188	73.264	79.512	87.106	92.452	97.502	103.766	108.217	121.412
73	55.188	73.264	79.512	87.106	92.452	97.502	103.766	108.217	121.412
74	64.012	73.417	74.997	76.252	76.827	77.205	77.514	77.658	77.868
75	69.281	92.803	99.338	106.285	110.564	114.172	118.100	120.546	126.285
76	74.864	106.828	117.922	131.439	140.980	150.012	161.244	169.246	193.072
77	70.320	87.472	92.408	97.769	101.142	104.039	107.258	109.306	114.289
78	60.042	69.543	71.893	74.225	75.564	76.629	77.713	78.342	79.656
79	64.624	80.187	84.327	88.616	91.189	93.312	95.564	96.931	100.000
80	68.581	86.280	91.864	98.277	102.546	106.389	110.901	113.934	122.069
81	58.438	74.316	79.718	86.217	90.748	94.993	100.208	103.877	114.564
82	87.892	126.887	141.302	159.574	172.986	186.116	203.087	215.654	255.830
83	68.553	95.706	105.151	116.674	124.819	132.539	142.152	149.009	169.479
84	74.054	99.724	108.158	118.092	124.870	131.105	138.605	143.772	158.259
85	68.553	95.706	105.151	116.674	124.819	132.539	142.152	149.009	169.479
86	65.799	85.551	92.456	100.908	106.900	112.595	119.709	124.799	140.081
87	83.089	120.587	133.804	150.064	161.651	172.710	186.594	196.578	226.825
88	68.581	86.280	91.864	98.277	102.546	106.389	110.901	113.934	122.069
89	55.188	73.264	79.512	87.106	92.452	97.502	103.766	108.217	121.412
90	72.691	93.169	100.376	109.234	115.541	121.556	129.099	134.519	150.913
91	44.423	56.595	60.558	65.198	68.347	71.229	74.677	77.039	83.595
92	71.871	97.398	106.010	116.320	123.471	130.140	138.293	144.001	160.473
93	74.600	99.643	105.610	111.400	114.653	117.191	119.718	121.155	124.044
94	66.498	82.454	87.938	94.582	99.243	103.633	109.061	112.906	124.232
95	64.624	80.187	84.327	88.616	91.189	93.312	95.564	96.931	100.000
96	69.281	92.803	99.338	106.285	110.564	114.172	118.100	120.546	126.285
97	87.892	126.887	141.302	159.574	172.986	186.116	203.087	215.654	255.830
98	67.419	87.308	92.565	97.991	101.234	103.901	106.720	108.425	112.227
99	70.320	87.472	92.408	97.769	101.142	104.039	107.258	109.306	114.289
100	57.419	82.192	90.914	101.638	109.275	116.560	125.699	132.267	152.142
101	62.876	76.105	80.230	84.933	88.040	90.822	94.063	96.227	101.958
102	62.876	76.105	80.230	84.933	88.040	90.822	94.063	96.227	101.958
103	64.624	80.187	84.327	88.616	91.189	93.312	95.564	96.931	100.000
104	62.472	81.070	87.502	95.322	100.830	106.034	112.492	117.083	130.701

Station No.	Estimated Rainfall Depths of ECMWF 2-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	100.203	140.651	154.271	170.556	181.838	192.349	205.184	214.159	240.005
2	77.941	98.629	105.590	113.909	119.670	125.035	131.583	136.159	149.329
3	89.409	127.486	140.563	156.392	167.492	177.942	190.854	199.993	226.891
4	82.789	98.648	102.601	106.542	108.817	110.632	112.488	113.571	115.851
5	74.135	100.913	110.323	121.876	130.094	137.924	147.735	154.777	176.037
6	60.299	77.257	82.637	88.836	92.975	96.713	101.116	104.085	112.096
7	78.437	97.733	104.468	112.702	118.535	124.073	130.984	135.924	150.727
9	86.252	97.586	99.101	100.163	100.589	100.841	101.023	101.098	101.187
10	67.666	86.262	92.830	100.920	106.693	112.209	119.141	124.133	139.291
12	88.503	117.575	127.752	140.218	149.064	157.476	167.993	175.524	198.166
13	87.604	117.276	127.776	140.727	149.979	158.829	169.966	177.994	202.428
14	81.906	111.630	121.983	134.627	143.570	152.053	162.626	170.174	192.741
15	83.470	122.621	136.487	153.597	165.826	177.528	192.262	202.888	235.257
16	75.318	100.767	109.332	119.571	126.663	133.269	141.332	146.969	163.196
17	81.846	99.075	104.721	111.361	115.885	120.040	125.031	128.465	138.064
18	87.220	105.735	109.159	112.030	113.421	114.378	115.204	115.610	116.253
19	87.604	117.276	127.776	140.727	149.979	158.829	169.966	177.994	202.428
20	82.789	98.648	102.601	106.542	108.817	110.632	112.488	113.571	115.851
21	82.789	98.648	102.601	106.542	108.817	110.632	112.488	113.571	115.851
22	83.470	122.621	136.487	153.597	165.826	177.528	192.262	202.888	235.257
23	68.703	86.383	92.072	98.687	103.143	107.197	112.013	115.289	124.268
24	80.980	111.141	121.826	135.013	144.440	153.461	164.822	173.017	197.986
25	81.779	103.735	111.477	121.003	127.794	134.276	142.416	148.270	166.016
26	74.744	91.037	96.305	102.450	106.602	110.389	114.902	117.981	126.465
27	87.220	105.735	109.159	112.030	113.421	114.378	115.204	115.610	116.253
28	82.371	121.662	136.654	156.043	170.560	185.013	204.065	218.451	266.141
29	89.409	127.486	140.563	156.392	167.492	177.942	190.854	199.993	226.891
30	96.868	132.888	144.333	157.537	166.364	174.342	183.749	190.099	207.266
31	82.551	103.897	110.605	118.291	123.395	127.981	133.353	136.955	146.577
32	86.804	117.341	128.040	141.154	150.465	159.324	170.406	178.345	202.241
33	80.980	111.141	121.826	135.013	144.440	153.461	164.822	173.017	197.986
34	60.697	76.068	80.959	86.608	90.388	93.807	97.843	100.569	107.953
35	79.450	95.863	100.889	106.558	110.263	113.548	117.336	119.837	126.335
36	79.450	95.863	100.889	106.558	110.263	113.548	117.336	119.837	126.335
37	86.804	117.341	128.040	141.154	150.465	159.324	170.406	178.345	202.241
38	81.464	101.593	108.633	117.254	123.367	129.179	136.441	141.639	157.251
39	96.606	129.503	141.003	155.077	165.054	174.536	186.379	194.852	220.286
40	80.980	111.141	121.826	135.013	144.440	153.461	164.822	173.017	197.986
41	77.941	98.629	105.590	113.909	119.670	125.035	131.583	136.159	149.329
42	82.630	102.434	107.206	111.868	114.505	116.574	118.647	119.834	122.248
43	79.450	95.863	100.889	106.558	110.263	113.548	117.336	119.837	126.335
44	93.412	134.991	149.579	167.474	180.190	192.298	207.455	218.324	251.084
45	72.996	92.919	99.517	107.325	112.679	117.624	123.602	127.740	139.440

Con'td									
46	68.703	86.383	92.072	98.687	103.143	107.197	112.013	115.289	124.268
47	93.412	134.991	149.579	167.474	180.190	192.298	207.455	218.324	251.084
48	80.433	96.819	102.150	108.391	112.624	116.497	121.129	124.301	133.099
49	81.464	101.593	108.633	117.254	123.367	129.179	136.441	141.639	157.251
51	78.459	95.149	99.128	102.991	105.162	106.856	108.544	109.505	111.437
52	77.941	98.629	105.590	113.909	119.670	125.035	131.583	136.159	149.329
53	81.846	99.075	104.721	111.361	115.885	120.040	125.031	128.465	138.064
54	82.371	121.662	136.654	156.043	170.560	185.013	204.065	218.451	266.141
56	74.135	100.913	110.323	121.876	130.094	137.924	147.735	154.777	176.037
57	79.134	99.688	106.811	115.481	121.595	127.378	134.564	139.678	154.880
58	100.203	140.651	154.271	170.556	181.838	192.349	205.184	214.159	240.005
59	77.941	98.629	105.590	113.909	119.670	125.035	131.583	136.159	149.329
60	86.252	97.586	99.101	100.163	100.589	100.841	101.023	101.098	101.187
62	86.252	97.586	99.101	100.163	100.589	100.841	101.023	101.098	101.187
63	79.033	97.939	104.685	113.048	119.053	124.822	132.119	137.406	153.644
65	81.281	102.293	107.932	113.806	117.349	120.285	123.418	125.329	129.658
66	72.036	91.408	98.206	106.547	112.475	118.120	125.188	130.257	145.540
67	68.703	86.383	92.072	98.687	103.143	107.197	112.013	115.289	124.268
68	72.036	91.408	98.206	106.547	112.475	118.120	125.188	130.257	145.540
69	96.868	132.888	144.333	157.537	166.364	174.342	183.749	190.099	207.266
70	75.318	100.767	109.332	119.571	126.663	133.269	141.332	146.969	163.196
71	100.010	136.319	145.873	155.706	161.568	166.377	171.449	174.507	181.296
72	68.703	86.383	92.072	98.687	103.143	107.197	112.013	115.289	124.268
73	68.703	86.383	92.072	98.687	103.143	107.197	112.013	115.289	124.268
74	89.367	112.966	119.883	127.479	132.312	136.502	141.209	144.236	151.746
77	82.551	103.897	110.605	118.291	123.395	127.981	133.353	136.955	146.577
78	78.524	93.837	99.027	105.258	109.592	113.644	118.611	122.098	132.213
79	82.789	98.648	102.601	106.542	108.817	110.632	112.488	113.571	115.851
80	80.889	102.417	109.661	118.320	124.315	129.900	136.716	141.480	155.190
81	79.033	97.939	104.685	113.048	119.053	124.822	132.119	137.406	153.644
82	105.692	144.320	156.725	171.130	180.822	189.631	200.083	207.185	226.605
83	81.906	111.630	121.983	134.627	143.570	152.053	162.626	170.174	192.741
85	81.906	111.630	121.983	134.627	143.570	152.053	162.626	170.174	192.741
86	83.791	102.652	108.124	114.095	117.870	121.126	124.761	127.084	132.786
87	100.203	140.651	154.271	170.556	181.838	192.349	205.184	214.159	240.005
88	80.889	102.417	109.661	118.320	124.315	129.900	136.716	141.480	155.190
89	68.703	86.383	92.072	98.687	103.143	107.197	112.013	115.289	124.268
90	89.187	115.731	125.310	137.268	145.915	154.271	164.914	172.678	196.830
91	61.350	77.956	83.750	90.832	95.848	100.609	106.549	110.793	123.508
92	87.604	117.276	127.776	140.727	149.979	158.829	169.966	177.994	202.428
94	81.846	99.075	104.721	111.361	115.885	120.040	125.031	128.465	138.064
95	82.789	98.648	102.601	106.542	108.817	110.632	112.488	113.571	115.851
96	91.304	124.270	134.606	146.432	154.273	161.311	169.542	175.054	189.741
97	105.692	144.320	156.725	171.130	180.822	189.631	200.083	207.185	226.605
98	81.281	102.293	107.932	113.806	117.349	120.285	123.418	125.329	129.658
99	82.551	103.897	110.605	118.291	123.395	127.981	133.353	136.955	146.577
100	74.135	100.913	110.323	121.876	130.094	137.924	147.735	154.777	176.037
102	81.464	101.593	108.633	117.254	123.367	129.179	136.441	141.639	157.251
103	77.941	98.629	105.590	113.909	119.670	125.035	131.583	136.159	149.329
104	82.789	98.648	102.601	106.542	108.817	110.632	112.488	113.571	115.851

Station No.	Estimated Rainfall Depths of ECMWF 3 -day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	105.930	142.918	155.039	169.289	178.997	187.914	198.623	205.989	226.579
2	90.326	116.399	125.651	137.081	145.259	153.093	162.969	170.099	191.865
3	94.248	130.248	142.833	158.237	169.158	179.537	192.501	201.777	229.623
4	97.294	115.000	119.525	124.102	126.783	128.950	131.196	132.528	135.398
5	79.879	108.182	118.776	132.311	142.323	152.190	165.042	174.633	205.731
6	74.492	95.765	103.254	112.461	119.016	125.269	133.113	138.749	155.801
7	85.986	108.175	116.262	126.424	133.817	141.000	150.205	156.963	178.222
9	98.061	111.300	113.220	114.627	115.219	115.582	115.857	115.974	116.125
10	81.678	97.137	101.403	105.921	108.694	111.024	113.551	115.118	118.771
12	93.454	121.451	132.064	145.732	155.923	166.033	179.306	189.289	222.128
13	95.408	123.757	133.691	145.867	154.513	162.739	173.029	180.403	202.596
14	88.448	113.756	122.239	132.355	139.344	145.840	153.750	159.266	175.074
15	88.548	128.866	143.617	162.194	175.743	188.933	205.875	218.340	257.727
16	82.912	107.714	116.247	126.587	133.847	140.687	149.149	155.145	172.827
17	95.575	117.883	125.687	135.243	142.022	148.466	156.519	162.284	179.604
18	98.423	122.063	127.010	131.461	133.777	135.471	137.039	137.865	139.332
19	95.408	123.757	133.691	145.867	154.513	162.739	173.029	180.403	202.596
20	97.294	115.000	119.525	124.102	126.783	128.950	131.196	132.528	135.398
21	97.294	115.000	119.525	124.102	126.783	128.950	131.196	132.528	135.398
22	88.548	128.866	143.617	162.194	175.743	188.933	205.875	218.340	257.727
23	77.524	98.461	105.839	114.912	121.377	127.545	135.288	140.854	157.712
24	85.988	113.508	123.258	135.290	143.892	152.124	162.491	169.969	192.755
25	95.917	125.324	135.985	149.335	159.015	168.394	180.373	189.138	216.545
26	92.947	110.162	114.512	118.883	121.427	123.471	125.577	126.816	129.459
27	98.423	122.063	127.010	131.461	133.777	135.471	137.039	137.865	139.332
28	89.193	127.671	142.155	160.726	174.512	188.139	205.951	219.289	262.817
29	94.248	130.248	142.833	158.237	169.158	179.537	192.501	201.777	229.623
30	124.705	162.199	171.767	181.436	187.095	191.666	196.401	199.204	205.239
31	96.633	111.714	115.581	119.500	121.800	123.663	125.597	126.746	129.230
32	97.946	125.608	135.341	147.302	155.817	163.936	174.117	181.431	203.546
33	85.988	113.508	123.258	135.290	143.892	152.124	162.491	169.969	192.755
34	75.850	96.036	102.504	110.003	115.042	119.616	125.035	128.712	138.743
35	94.665	116.615	123.333	130.907	135.855	140.241	145.297	148.634	157.300
36	94.665	116.615	123.333	130.907	135.855	140.241	145.297	148.634	157.300
37	97.946	125.608	135.341	147.302	155.817	163.936	174.117	181.431	203.546
38	96.805	120.951	129.422	139.812	147.195	154.224	163.023	169.332	188.347
39	102.839	138.269	150.695	165.936	176.763	187.071	199.971	209.221	237.088
40	85.988	113.508	123.258	135.290	143.892	152.124	162.491	169.969	192.755
41	90.326	116.399	125.651	137.081	145.259	153.093	162.969	170.099	191.865
42	93.887	115.235	120.487	125.682	128.657	131.016	133.409	134.796	137.674
43	94.665	116.615	123.333	130.907	135.855	140.241	145.297	148.634	157.300
44	97.685	135.910	149.189	165.377	176.809	187.636	201.109	210.711	239.333
45	86.680	110.997	119.591	130.181	137.740	144.964	154.048	160.592	180.473

Con'td									
46	77.524	98.461	105.839	114.912	121.377	127.545	135.288	140.854	157.712
47	97.685	135.910	149.189	165.377	176.809	187.636	201.109	210.711	239.333
48	100.408	117.984	122.885	128.108	131.332	134.057	137.029	138.885	143.255
49	96.805	120.951	129.422	139.812	147.195	154.224	163.023	169.332	188.347
51	95.341	121.097	128.666	136.993	142.300	146.907	152.091	155.430	163.737
52	90.326	116.399	125.651	137.081	145.259	153.093	162.969	170.099	191.865
53	95.575	117.883	125.687	135.243	142.022	148.466	156.519	162.284	179.604
54	89.193	127.671	142.155	160.726	174.512	188.139	205.951	219.289	262.817
56	79.879	108.182	118.776	132.311	142.323	152.190	165.042	174.633	205.731
57	83.857	101.356	107.046	113.706	118.222	122.353	127.293	130.675	140.050
58	105.930	142.918	155.039	169.289	178.997	187.914	198.623	205.989	226.579
59	90.326	116.399	125.651	137.081	145.259	153.093	162.969	170.099	191.865
60	98.061	111.300	113.220	114.627	115.219	115.582	115.857	115.974	116.125
62	98.061	111.300	113.220	114.627	115.219	115.582	115.857	115.974	116.125
63	96.894	119.862	127.552	136.714	143.038	148.913	156.060	161.041	175.294
65	92.678	109.475	113.344	117.024	119.052	120.607	122.125	122.972	124.620
66	82.639	104.196	111.658	120.736	127.132	133.180	140.689	146.029	161.886
67	77.524	98.461	105.839	114.912	121.377	127.545	135.288	140.854	157.712
68	82.639	104.196	111.658	120.736	127.132	133.180	140.689	146.029	161.886
69	124.705	162.199	171.767	181.436	187.095	191.666	196.401	199.204	205.239
70	82.912	107.714	116.247	126.587	133.847	140.687	149.149	155.145	172.827
71	74.492	95.765	103.254	112.461	119.016	125.269	133.113	138.749	155.801
72	77.524	98.461	105.839	114.912	121.377	127.545	135.288	140.854	157.712
73	77.524	98.461	105.839	114.912	121.377	127.545	135.288	140.854	157.712
74	109.952	136.679	144.017	151.764	156.502	160.474	164.768	167.423	173.578
77	96.633	111.714	115.581	119.500	121.800	123.663	125.597	126.746	129.230
78	100.483	123.829	132.094	142.290	149.575	156.545	165.319	171.645	190.905
79	97.294	115.000	119.525	124.102	126.783	128.950	131.196	132.528	135.398
80	96.215	117.614	123.805	130.552	134.811	138.479	142.569	145.178	151.566
81	96.894	119.862	127.552	136.714	143.038	148.913	156.060	161.041	175.294
82	109.258	153.077	168.742	188.186	202.163	215.604	232.624	244.971	282.973
83	88.448	113.756	122.239	132.355	139.344	145.840	153.750	159.266	175.074
85	88.448	113.756	122.239	132.355	139.344	145.840	153.750	159.266	175.074
86	93.413	112.515	117.868	123.590	127.133	130.135	133.419	135.475	140.343
87	105.930	142.918	155.039	169.289	178.997	187.914	198.623	205.989	226.579
88	96.215	117.614	123.805	130.552	134.811	138.479	142.569	145.178	151.566
89	77.524	98.461	105.839	114.912	121.377	127.545	135.288	140.854	157.712
90	96.966	121.281	129.527	139.431	146.322	152.766	160.669	166.219	182.329
91	76.387	96.582	103.724	112.528	118.816	124.828	132.390	137.840	154.413
92	95.408	123.757	133.691	145.867	154.513	162.739	173.029	180.403	202.596
94	95.575	117.883	125.687	135.243	142.022	148.466	156.519	162.284	179.604
95	97.294	115.000	119.525	124.102	126.783	128.950	131.196	132.528	135.398
96	120.925	159.159	168.869	178.654	184.365	188.966	193.719	196.526	202.537
97	109.258	153.077	168.742	188.186	202.163	215.604	232.624	244.971	282.973
98	92.678	109.475	113.344	117.024	119.052	120.607	122.125	122.972	124.620
99	96.633	111.714	115.581	119.500	121.800	123.663	125.597	126.746	129.230
100	96.633	111.714	115.581	119.500	121.800	123.663	125.597	126.746	129.230
102	96.805	120.951	129.422	139.812	147.195	154.224	163.023	169.332	188.347
103	90.326	116.399	125.651	137.081	145.259	153.093	162.969	170.099	191.865
104	97.294	115.000	119.525	124.102	126.783	128.950	131.196	132.528	135.398

Station No.	Rainfall Depths of ECMWF bias Correction 1-Day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	45.498	59.844	64.778	70.754	74.948	78.899	83.785	87.247	97.448
2	39.462	49.903	53.599	58.158	61.416	64.532	68.455	71.283	79.894
3	38.498	52.144	57.253	63.781	68.611	73.371	79.571	84.199	99.208
4	38.760	44.496	45.754	46.917	47.539	48.005	48.447	48.687	49.132
5	33.823	43.681	47.167	51.465	54.534	57.468	61.159	63.819	71.907
6	29.900	34.720	36.260	38.043	39.238	40.322	41.603	42.471	44.831
7	37.109	45.546	48.849	53.191	56.494	59.829	64.296	67.723	79.425
8	51.751	70.698	77.410	85.693	91.614	97.281	104.416	109.564	125.246
9	42.574	58.690	63.741	69.519	73.349	76.787	80.806	83.497	90.666
10	34.610	42.892	45.882	49.614	52.314	54.923	58.246	60.671	68.216
11	34.610	42.892	45.882	49.614	52.314	54.923	58.246	60.671	68.216
12	44.755	59.227	64.353	70.677	75.198	79.523	84.969	88.897	100.861
13	43.110	55.862	60.311	65.750	69.601	73.257	77.819	81.079	90.844
14	39.626	52.159	56.563	61.970	65.816	69.480	74.071	77.366	87.315
15	49.618	55.195	55.777	56.135	56.260	56.326	56.368	56.383	56.398
16	37.632	48.293	51.796	55.922	58.738	61.328	64.443	66.590	72.609
17	39.021	46.644	48.956	51.547	53.231	54.717	56.420	57.538	60.413
18	41.335	53.395	56.626	59.989	62.016	63.694	65.482	66.572	69.038
19	43.110	55.862	60.311	65.750	69.601	73.257	77.819	81.079	90.844
20	38.367	43.766	44.970	46.094	46.701	47.159	47.598	47.839	48.292
21	49.618	55.195	55.777	56.135	56.260	56.326	56.368	56.383	56.398
22	49.618	55.195	55.777	56.135	56.260	56.326	56.368	56.383	56.398
23	34.449	43.118	46.174	49.933	52.611	55.167	58.377	60.684	67.674
24	37.722	47.892	51.103	54.794	57.252	59.467	62.068	63.817	68.516
25	45.408	51.407	52.359	53.091	53.416	53.624	53.788	53.863	53.965
26	40.659	51.332	54.419	57.783	59.907	61.736	63.774	65.075	68.258
27	41.335	53.395	56.626	59.989	62.016	63.694	65.482	66.572	69.038
28	36.212	50.265	55.245	61.390	65.783	69.988	75.283	79.103	90.744
29	38.498	52.144	57.253	63.781	68.611	73.371	79.571	84.199	99.208
30	63.720	78.173	80.412	82.114	82.858	83.328	83.697	83.861	84.083
31	43.474	54.297	57.272	60.416	62.340	63.954	65.700	66.781	69.289
32	44.885	61.422	66.566	72.425	76.291	79.747	83.770	86.451	93.538
33	37.722	47.892	51.103	54.794	57.252	59.467	62.068	63.817	68.516
34	29.053	36.078	38.794	42.336	45.011	47.692	51.256	53.970	63.102
35	35.576	40.168	41.317	42.465	43.129	43.660	44.204	44.522	45.194
36	35.576	40.168	41.317	42.465	43.129	43.660	44.204	44.522	45.194
37	44.885	61.422	66.566	72.425	76.291	79.747	83.770	86.451	93.538
38	40.005	50.049	53.671	58.189	61.454	64.608	68.623	71.550	80.646
39	45.739	61.821	67.937	75.830	81.728	87.589	95.300	101.110	120.298
40	37.722	47.892	51.103	54.794	57.252	59.467	62.068	63.817	68.516
41	39.462	49.903	53.599	58.158	61.416	64.532	68.455	71.283	79.894
42	40.292	52.107	55.698	59.728	62.349	64.664	67.321	69.067	73.566
43	35.877	41.181	42.555	43.955	44.782	45.454	46.157	46.576	47.493
44	42.923	59.864	65.803	73.087	78.260	83.183	89.344	93.761	107.062
45	37.820	46.251	49.127	52.593	55.014	57.285	60.079	62.049	67.803
46	34.449	43.118	46.174	49.933	52.611	55.167	58.377	60.684	67.674
47	42.923	59.864	65.803	73.087	78.260	83.183	89.344	93.761	107.062
48	42.458	54.162	58.069	62.716	65.918	68.889	72.496	75.005	82.164
49	40.005	50.049	53.671	58.189	61.454	64.608	68.623	71.550	80.646
50	39.736	50.740	54.609	59.362	62.743	65.966	70.005	72.906	81.668
51	39.309	47.014	49.403	52.116	53.902	55.496	57.347	58.578	61.818
52	39.462	49.903	53.599	58.158	61.416	64.532	68.455	71.283	79.894

Con'td									
53	39.021	46.644	48.956	51.547	53.231	54.717	56.420	57.538	60.413
54	36.212	50.265	55.245	61.390	65.783	69.988	75.283	79.103	90.744
55	39.364	48.733	51.951	55.846	58.578	61.149	64.327	66.576	73.196
56	33.823	43.681	47.167	51.465	54.534	57.468	61.159	63.819	71.907
57	40.313	50.098	53.353	57.216	59.872	62.332	65.312	67.381	73.260
58	45.498	59.844	64.778	70.754	74.948	78.899	83.785	87.247	97.448
59	39.462	49.903	53.599	58.158	61.416	64.532	68.455	71.283	79.894
60	42.574	58.690	63.741	69.519	73.349	76.787	80.806	83.497	90.666
61	42.574	58.690	63.741	69.519	73.349	76.787	80.806	83.497	90.666
62	42.574	58.690	63.741	69.519	73.349	76.787	80.806	83.497	90.666
63	36.710	45.800	49.021	52.997	55.839	58.559	61.984	64.456	71.986
64	62.091	71.846	72.955	73.667	73.928	74.071	74.166	74.202	74.239
65	38.505	46.394	48.522	50.745	52.090	53.207	54.403	55.135	56.801
66	37.669	48.944	52.802	57.462	60.723	63.788	67.566	70.235	78.058
67	34.449	43.118	46.174	49.933	52.611	55.167	58.377	60.684	67.674
68	37.669	48.944	52.802	57.462	60.723	63.788	67.566	70.235	78.058
69	63.720	78.173	80.412	82.114	82.858	83.328	83.697	83.861	84.083
70	37.632	48.293	51.796	55.922	58.738	61.328	64.443	66.590	72.609
71	29.743	33.733	34.924	36.247	37.098	37.843	38.688	39.238	40.628
72	34.449	43.118	46.174	49.933	52.611	55.167	58.377	60.684	67.674
73	34.449	43.118	46.174	49.933	52.611	55.167	58.377	60.684	67.674
74	57.457	73.836	77.535	81.014	82.908	84.347	85.736	86.502	87.964
75	56.025	62.701	63.389	63.809	63.955	64.032	64.080	64.097	64.114
76	49.898	56.330	57.155	57.719	57.941	58.069	58.160	58.196	58.238
77	43.474	54.297	57.272	60.416	62.340	63.954	65.700	66.781	69.289
78	39.736	51.904	56.208	61.514	65.304	68.927	73.485	76.770	86.760
79	38.760	44.496	45.754	46.917	47.539	48.005	48.447	48.687	49.132
80	43.214	51.573	53.430	55.161	56.095	56.798	57.471	57.839	58.530
81	36.710	45.800	49.021	52.997	55.839	58.559	61.984	64.456	71.986
82	52.763	62.576	64.320	65.751	66.429	66.886	67.272	67.458	67.742
83	39.626	52.159	56.563	61.970	65.816	69.480	74.071	77.366	87.315
84	51.751	70.698	77.410	85.693	91.614	97.281	104.416	109.564	125.246
85	39.626	52.159	56.563	61.970	65.816	69.480	74.071	77.366	87.315
86	40.645	52.318	56.658	62.179	66.245	70.238	75.417	79.265	91.647
87	45.498	59.844	64.778	70.754	74.948	78.899	83.785	87.247	97.448
88	43.214	51.573	53.430	55.161	56.095	56.798	57.471	57.839	58.530
89	34.449	43.118	46.174	49.933	52.611	55.167	58.377	60.684	67.674
90	43.722	56.861	61.804	68.139	72.840	77.486	83.555	88.099	102.917
91	35.644	46.050	49.735	54.283	57.533	60.643	64.560	67.385	75.989
92	43.110	55.862	60.311	65.750	69.601	73.257	77.819	81.079	90.844
93	62.091	71.846	72.955	73.667	73.928	74.071	74.166	74.202	74.239
94	39.021	46.644	48.956	51.547	53.231	54.717	56.420	57.538	60.413
95	38.760	44.496	45.754	46.917	47.539	48.005	48.447	48.687	49.132
96	56.025	62.701	63.389	63.809	63.955	64.032	64.080	64.097	64.114
97	52.763	62.576	64.320	65.751	66.429	66.886	67.272	67.458	67.742
98	38.505	46.394	48.522	50.745	52.090	53.207	54.403	55.135	56.801
99	43.474	54.297	57.272	60.416	62.340	63.954	65.700	66.781	69.289
100	33.823	43.681	47.167	51.465	54.534	57.468	61.159	63.819	71.907
101	40.005	50.049	53.671	58.189	61.454	64.608	68.623	71.550	80.646
102	40.005	50.049	53.671	58.189	61.454	64.608	68.623	71.550	80.646
103	39.462	49.903	53.599	58.158	61.416	64.532	68.455	71.283	79.894
104	38.760	44.496	45.754	46.917	47.539	48.005	48.447	48.687	49.132

Station No.	Rainfall Depths of ECMWF bias Correction 2-Day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	57.509	74.142	80.285	88.066	93.773	99.357	106.571	111.909	128.952
2	52.962	66.435	71.206	77.092	81.298	85.323	90.390	94.044	105.170
3	52.584	67.806	73.082	79.506	84.037	88.324	93.651	97.443	108.720
4	52.590	58.189	59.385	60.475	61.049	61.472	61.869	62.081	62.464
5	47.481	57.393	60.820	64.985	67.917	70.688	74.125	76.568	83.810
6	43.454	52.439	55.527	59.268	61.892	64.363	67.419	69.583	75.957
7	49.517	58.016	61.027	64.743	67.400	69.943	73.145	75.456	82.496
9	54.678	71.643	77.121	83.504	87.813	91.741	96.417	99.604	108.373
10	49.345	61.868	66.302	71.774	75.683	79.424	84.134	87.530	97.872
12	55.434	71.110	77.087	84.813	90.595	96.349	103.930	109.652	128.603
13	56.783	71.312	76.693	83.523	88.542	93.460	99.826	104.545	119.664
14	51.244	65.079	70.214	76.738	81.538	86.247	92.348	96.877	111.417
15	58.792	64.538	65.161	65.551	65.691	65.765	65.814	65.832	65.850
16	50.744	64.424	69.240	75.161	79.377	83.399	88.444	92.069	103.038
17	50.665	59.532	62.736	66.738	69.634	72.434	76.003	78.609	86.723
18	53.163	62.356	64.277	66.006	66.905	67.563	68.171	68.491	69.059
19	56.783	71.312	76.693	83.523	88.542	93.460	99.826	104.545	119.664
20	52.590	58.189	59.385	60.475	61.049	61.472	61.869	62.081	62.464
21	52.590	58.189	59.385	60.475	61.049	61.472	61.869	62.081	62.464
22	58.792	64.538	65.161	65.551	65.691	65.765	65.814	65.832	65.850
23	47.335	57.786	61.485	66.048	69.308	72.426	76.350	79.180	87.792
24	51.443	63.764	67.677	72.190	75.205	77.930	81.141	83.308	89.163
25	54.766	63.867	66.084	68.262	69.502	70.481	71.467	72.035	73.202
26	49.515	60.273	63.976	68.465	71.617	74.589	78.266	80.872	88.563
27	53.163	62.356	64.277	66.006	66.905	67.563	68.171	68.491	69.059
28	50.590	63.179	67.281	72.086	75.349	78.337	81.913	84.364	91.175
29	52.584	67.806	73.082	79.506	84.037	88.324	93.651	97.443	108.720
30	83.108	95.066	96.596	97.643	98.054	98.291	98.459	98.526	98.604
31	53.832	68.572	74.090	81.140	86.355	91.495	98.190	103.187	119.390
32	60.493	77.579	82.875	88.892	92.854	96.389	100.495	103.226	110.414
33	51.443	63.764	67.677	72.190	75.205	77.930	81.141	83.308	89.163
34	45.104	55.213	58.960	63.718	67.216	70.645	75.086	78.379	88.940
35	49.948	57.986	60.674	63.874	66.082	68.131	70.622	72.357	77.315
36	49.948	57.986	60.674	63.874	66.082	68.131	70.622	72.357	77.315
37	60.493	77.579	82.875	88.892	92.854	96.389	100.495	103.226	110.414
38	56.827	70.463	75.237	81.084	85.234	89.180	94.113	97.646	108.267
39	57.268	73.349	79.199	86.541	91.877	97.057	103.686	108.547	123.810
40	51.443	63.764	67.677	72.190	75.205	77.930	81.141	83.308	89.163
41	52.962	66.435	71.206	77.092	81.298	85.323	90.390	94.044	105.170
42	51.455	63.992	68.062	72.820	76.043	78.988	82.507	84.913	91.571
43	49.948	57.986	60.674	63.874	66.082	68.131	70.622	72.357	77.315
44	55.052	73.694	80.701	89.679	96.338	102.915	111.506	117.933	138.878
45	50.646	62.428	66.598	71.743	75.419	78.935	83.361	86.552	96.266

Con'td									
46	47.335	57.786	61.485	66.048	69.308	72.426	76.350	79.180	87.792
47	55.052	73.694	80.701	89.679	96.338	102.915	111.506	117.933	138.878
48	53.612	64.604	68.394	72.991	76.223	79.271	83.046	85.724	93.639
49	56.827	70.463	75.237	81.084	85.234	89.180	94.113	97.646	108.267
51	51.215	62.815	66.912	71.958	75.558	78.999	83.322	86.436	95.888
52	52.962	66.435	71.206	77.092	81.298	85.323	90.390	94.044	105.170
53	50.665	59.532	62.736	66.738	69.634	72.434	76.003	78.609	86.723
54	50.590	63.179	67.281	72.086	75.349	78.337	81.913	84.364	91.175
56	47.481	57.393	60.820	64.985	67.917	70.688	74.125	76.568	83.810
57	51.942	62.442	66.163	70.755	74.038	77.179	81.136	83.991	92.689
58	57.509	74.142	80.285	88.066	93.773	99.357	106.571	111.909	128.952
59	52.962	66.435	71.206	77.092	81.298	85.323	90.390	94.044	105.170
60	54.678	71.643	77.121	83.504	87.813	91.741	96.417	99.604	108.373
62	54.678	71.643	77.121	83.504	87.813	91.741	96.417	99.604	108.373
63	50.278	58.147	60.911	64.306	66.720	69.020	71.902	73.970	80.215
65	51.226	60.935	63.777	66.896	68.879	70.597	72.526	73.765	76.836
66	51.794	66.505	71.662	77.984	82.474	86.746	92.092	95.924	107.459
67	47.335	57.786	61.485	66.048	69.308	72.426	76.350	79.180	87.792
68	51.794	66.505	71.662	77.984	82.474	86.746	92.092	95.924	107.459
69	83.108	95.066	96.596	97.643	98.054	98.291	98.459	98.526	98.604
70	50.744	64.424	69.240	75.161	79.377	83.399	88.444	92.069	103.038
71	43.454	52.439	55.527	59.268	61.892	64.363	67.419	69.583	75.957
72	47.335	57.786	61.485	66.048	69.308	72.426	76.350	79.180	87.792
73	47.335	57.786	61.485	66.048	69.308	72.426	76.350	79.180	87.792
74	74.480	85.596	87.438	88.891	89.552	89.983	90.334	90.496	90.729
77	53.832	68.572	74.090	81.140	86.355	91.495	98.190	103.187	119.390
78	51.444	58.674	61.199	64.287	66.476	68.554	71.148	73.004	78.567
79	52.590	58.189	59.385	60.475	61.049	61.472	61.869	62.081	62.464
80	53.224	66.118	70.639	76.184	80.123	83.872	88.564	91.928	102.060
81	50.278	58.147	60.911	64.306	66.720	69.020	71.902	73.970	80.215
82	63.480	82.156	87.727	93.910	97.887	101.366	105.315	107.881	114.366
83	51.244	65.079	70.214	76.738	81.538	86.247	92.348	96.877	111.417
85	51.244	65.079	70.214	76.738	81.538	86.247	92.348	96.877	111.417
86	56.218	67.330	70.618	74.249	76.573	78.597	80.884	82.363	86.069
87	57.509	74.142	80.285	88.066	93.773	99.357	106.571	111.909	128.952
88	53.224	66.118	70.639	76.184	80.123	83.872	88.564	91.928	102.060
89	47.335	57.786	61.485	66.048	69.308	72.426	76.350	79.180	87.792
90	57.259	70.066	74.266	79.209	82.577	85.673	89.394	91.955	99.120
91	51.386	63.970	68.176	73.183	76.636	79.841	83.737	86.449	94.197
92	56.783	71.312	76.693	83.523	88.542	93.460	99.826	104.545	119.664
94	50.665	59.532	62.736	66.738	69.634	72.434	76.003	78.609	86.723
95	52.590	58.189	59.385	60.475	61.049	61.472	61.869	62.081	62.464
96	73.051	77.766	78.115	78.295	78.347	78.371	78.383	78.387	78.390
97	63.480	82.156	87.727	93.910	97.887	101.366	105.315	107.881	114.366
98	51.226	60.935	63.777	66.896	68.879	70.597	72.526	73.765	76.836
99	53.832	68.572	74.090	81.140	86.355	91.495	98.190	103.187	119.390
100	47.481	57.393	60.820	64.985	67.917	70.688	74.125	76.568	83.810
102	56.827	70.463	75.237	81.084	85.234	89.180	94.113	97.646	108.267
103	52.962	66.435	71.206	77.092	81.298	85.323	90.390	94.044	105.170
104	52.590	58.189	59.385	60.475	61.049	61.472	61.869	62.081	62.464

Station No.	Rainfall Depths of ECMWF bias Correction 3-Day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	65.104	79.181	83.681	88.891	92.387	95.557	99.307	101.848	108.762
2	64.853	80.802	86.452	93.425	98.410	103.180	109.187	113.520	126.722
3	60.012	72.307	76.216	80.727	83.744	86.472	89.688	91.861	97.738
4	65.627	73.314	75.207	77.079	78.152	79.003	79.866	80.366	81.406
5	56.368	69.371	74.279	80.582	85.270	89.911	95.987	100.544	115.465
6	56.973	65.787	68.372	71.212	73.020	74.588	76.350	77.483	80.298
7	59.561	68.907	71.913	75.405	77.757	79.897	82.437	84.164	88.895
9	65.608	80.906	85.254	89.940	92.867	95.365	98.120	99.860	104.039
10	60.664	72.576	76.643	81.548	84.974	88.191	92.151	94.943	103.109
12	64.151	77.863	82.467	87.962	91.762	95.297	99.605	102.612	111.245
13	65.615	80.932	86.357	93.051	97.836	102.414	108.178	112.336	124.999
14	59.300	72.882	77.662	83.539	87.723	91.713	96.719	100.315	111.194
15	63.687	75.665	78.029	80.087	81.122	81.857	82.516	82.851	83.416
16	59.443	72.401	76.972	82.597	86.608	90.438	95.247	98.708	109.201
17	64.529	77.375	82.075	87.993	92.309	96.510	101.906	105.877	118.419
18	64.058	78.306	82.176	86.236	88.703	90.760	92.970	94.328	97.441
19	65.615	80.932	86.357	93.051	97.836	102.414	108.178	112.336	124.999
20	65.627	73.314	75.207	77.079	78.152	79.003	79.866	80.366	81.406
21	65.627	73.314	75.207	77.079	78.152	79.003	79.866	80.366	81.406
22	63.687	75.665	78.029	80.087	81.122	81.857	82.516	82.851	83.416
23	57.110	68.825	73.164	78.670	82.717	86.681	91.812	95.616	107.800
24	57.890	69.984	74.106	79.071	82.536	85.784	89.780	92.594	100.807
25	67.748	77.545	79.544	81.319	82.229	82.886	83.486	83.798	84.339
26	63.579	79.532	85.085	91.863	96.656	101.200	106.861	110.901	122.970
27	64.058	78.306	82.176	86.236	88.703	90.760	92.970	94.328	97.441
28	59.183	71.299	75.039	79.277	82.060	84.537	87.408	89.312	94.301
29	60.012	72.307	76.216	80.727	83.744	86.472	89.688	91.861	97.738
30	95.512	99.534	99.750	99.844	99.867	99.876	99.880	99.881	99.882
31	67.173	76.037	78.377	80.789	82.230	83.414	84.665	85.421	87.104
32	71.511	86.961	91.559	96.655	99.929	102.788	106.030	108.134	113.438
33	57.890	69.984	74.106	79.071	82.536	85.784	89.780	92.594	100.807
34	60.340	69.802	72.395	75.130	76.800	78.199	79.710	80.643	82.802
35	63.055	70.785	73.008	75.420	76.937	78.238	79.684	80.604	82.838
36	63.055	70.785	73.008	75.420	76.937	78.238	79.684	80.604	82.838
37	71.511	86.961	91.559	96.655	99.929	102.788	106.030	108.134	113.438
38	68.583	83.669	89.302	96.489	101.798	107.022	113.818	118.881	135.255
39	64.996	77.503	81.280	85.503	88.240	90.649	93.404	95.207	99.823
40	57.890	69.984	74.106	79.071	82.536	85.784	89.780	92.594	100.807
41	64.853	80.802	86.452	93.425	98.410	103.180	109.187	113.520	126.722
42	62.182	75.656	80.131	85.436	89.079	92.450	96.530	99.360	107.386
43	63.055	70.785	73.008	75.420	76.937	78.238	79.684	80.604	82.838
44	62.152	78.096	83.524	90.060	94.619	98.891	104.142	107.840	118.618
45	63.802	77.520	82.379	88.373	92.658	96.758	101.919	105.642	116.980

Con'td									
46	57.110	68.825	73.164	78.670	82.717	86.681	91.812	95.616	107.800
47	62.152	78.096	83.524	90.060	94.619	98.891	104.142	107.840	118.618
48	68.706	80.984	84.859	89.310	92.273	94.942	98.075	100.182	105.835
49	68.583	83.669	89.302	96.489	101.798	107.022	113.818	118.881	135.255
51	64.456	79.216	84.587	91.328	96.227	100.983	107.072	111.537	125.557
52	64.853	80.802	86.452	93.425	98.410	103.180	109.187	113.520	126.722
53	64.529	77.375	82.075	87.993	92.309	96.510	101.906	105.877	118.419
54	59.183	71.299	75.039	79.277	82.060	84.537	87.408	89.312	94.301
56	56.368	69.371	74.279	80.582	85.270	89.911	95.987	100.544	115.465
57	61.096	71.986	75.329	79.105	81.577	83.771	86.305	87.981	92.347
58	65.104	79.181	83.681	88.891	92.387	95.557	99.307	101.848	108.762
59	64.853	80.802	86.452	93.425	98.410	103.180	109.187	113.520	126.722
60	65.608	80.906	85.254	89.940	92.867	95.365	98.120	99.860	104.039
62	65.608	80.906	85.254	89.940	92.867	95.365	98.120	99.860	104.039
63	65.339	72.781	74.776	76.852	78.104	79.140	80.245	80.919	82.443
65	62.310	72.634	75.880	79.602	82.074	84.297	86.901	88.649	93.320
66	62.464	77.299	82.402	88.586	92.927	97.017	102.076	105.660	116.229
67	57.110	68.825	73.164	78.670	82.717	86.681	91.812	95.616	107.800
68	62.464	77.299	82.402	88.586	92.927	97.017	102.076	105.660	116.229
69	95.512	99.534	99.750	99.844	99.867	99.876	99.880	99.881	99.882
70	59.443	72.401	76.972	82.597	86.608	90.438	95.247	98.708	109.201
71	56.973	65.787	68.372	71.212	73.020	74.588	76.350	77.483	80.298
72	57.110	68.825	73.164	78.670	82.717	86.681	91.812	95.616	107.800
73	57.110	68.825	73.164	78.670	82.717	86.681	91.812	95.616	107.800
74	83.727	103.359	108.590	114.014	117.272	119.961	122.818	124.553	128.455
77	67.173	76.037	78.377	80.789	82.230	83.414	84.665	85.421	87.104
78	66.410	76.276	79.763	84.061	87.129	90.061	93.749	96.406	104.481
79	65.627	73.314	75.207	77.079	78.152	79.003	79.866	80.366	81.406
80	65.642	78.667	82.629	87.081	89.979	92.540	95.482	97.417	102.410
81	65.339	72.781	74.776	76.852	78.104	79.140	80.245	80.919	82.443
82	68.075	87.430	94.115	102.236	107.951	113.348	120.039	124.792	138.870
83	59.300	72.882	77.662	83.539	87.723	91.713	96.719	100.315	111.194
85	59.300	72.882	77.662	83.539	87.723	91.713	96.719	100.315	111.194
86	65.598	76.606	80.098	84.122	86.809	89.236	92.093	94.020	99.220
87	65.104	79.181	83.681	88.891	92.387	95.557	99.307	101.848	108.762
88	65.642	78.667	82.629	87.081	89.979	92.540	95.482	97.417	102.410
89	57.110	68.825	73.164	78.670	82.717	86.681	91.812	95.616	107.800
90	67.195	79.027	82.577	86.530	89.082	91.320	93.870	95.533	99.760
91	65.124	76.956	80.499	84.440	86.981	89.208	91.742	93.393	97.581
92	65.615	80.932	86.357	93.051	97.836	102.414	108.178	112.336	124.999
94	64.529	77.375	82.075	87.993	92.309	96.510	101.906	105.877	118.419
95	65.627	73.314	75.207	77.079	78.152	79.003	79.866	80.366	81.406
96	90.831	92.916	92.990	93.017	93.022	93.023	93.024	93.024	93.024
97	68.075	87.430	94.115	102.236	107.951	113.348	120.039	124.792	138.870
98	63.055	70.785	73.008	75.420	76.937	78.238	79.684	80.604	82.838
99	67.173	76.037	78.377	80.789	82.230	83.414	84.665	85.421	87.104
100	56.368	69.371	74.279	80.582	85.270	89.911	95.987	100.544	115.465
102	68.583	83.669	89.302	96.489	101.798	107.022	113.818	118.881	135.255
103	64.853	80.802	86.452	93.425	98.410	103.180	109.187	113.520	126.722
104	65.627	73.314	75.207	77.079	78.152	79.003	79.866	80.366	81.406

Station No.	Estimated Rainfall Depths of GLADS 1-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	93.483	130.829	144.349	161.261	173.514	185.375	200.511	211.575	246.113
2	90.439	126.504	139.277	155.038	166.303	177.083	190.656	200.445	230.262
3	90.696	121.272	131.751	144.418	153.289	161.631	171.926	179.204	200.571
4	129.881	181.517	197.015	214.282	225.428	235.210	246.356	253.625	272.117
5	82.105	104.156	111.062	118.960	124.193	128.888	134.375	138.048	147.824
6	134.156	215.859	246.416	285.435	314.285	342.702	379.699	407.293	496.681
7	98.337	131.765	142.465	154.867	163.194	170.751	179.699	185.768	202.305
8	155.162	244.733	276.351	315.284	343.053	369.578	402.907	426.896	499.693
9	96.231	130.987	143.635	159.509	171.047	182.247	196.586	207.101	240.122
10	90.183	121.777	132.914	146.615	156.378	165.698	177.397	185.811	211.302
11	90.183	121.777	132.914	146.615	156.378	165.698	177.397	185.811	211.302
12	111.987	150.632	164.082	180.498	192.105	203.109	216.816	226.598	255.815
13	108.741	151.581	166.634	185.115	198.260	210.785	226.479	237.743	271.748
14	112.828	149.159	161.069	175.075	184.619	193.387	203.921	211.167	231.433
15	83.720	117.729	129.693	144.394	154.858	164.834	177.344	186.329	213.492
16	74.148	88.400	91.927	95.428	97.440	99.039	100.668	101.614	103.591
17	108.366	157.218	174.038	194.430	208.751	222.252	238.960	250.803	285.759
18	108.315	149.891	165.171	184.469	198.583	212.356	230.095	243.184	284.750
19	108.201	143.131	153.313	164.456	171.524	177.632	184.473	188.858	199.672
20	128.460	184.629	202.362	222.737	236.304	248.526	262.878	272.530	298.440
21	128.460	184.629	202.362	222.737	236.304	248.526	262.878	272.530	298.440
22	81.288	117.500	131.071	148.425	161.273	173.942	190.459	202.793	242.849
23	77.319	91.573	94.967	98.260	100.110	101.552	102.988	103.805	105.445
24	107.173	142.306	153.857	167.465	176.754	185.302	195.587	202.676	222.563
25	87.260	114.090	121.997	130.708	136.270	141.104	146.553	150.068	158.839
26	96.800	119.024	124.609	130.201	133.444	136.043	138.712	140.278	143.596
27	110.966	153.968	169.099	187.693	200.928	213.550	229.377	240.747	275.125
28	64.589	84.574	92.150	101.907	109.182	116.400	125.875	133.001	156.445
29	90.696	121.272	131.751	144.418	153.289	161.631	171.926	179.204	200.571
30	124.039	186.390	208.161	234.788	253.652	271.567	293.929	309.917	357.849
31	117.307	170.691	188.529	209.755	224.389	237.969	254.471	265.958	298.755
32	85.721	121.721	134.432	150.087	161.255	171.924	185.333	194.986	224.288
33	107.173	142.306	153.857	167.465	176.754	185.302	195.587	202.676	222.563
34	118.534	165.198	179.626	195.994	206.755	216.344	227.466	234.851	254.240
35	115.298	166.350	184.920	208.222	225.156	241.590	262.624	278.046	326.453
36	110.952	152.717	166.573	182.988	194.256	204.673	217.277	226.012	250.759
37	121.649	186.207	208.903	236.779	256.612	275.515	299.208	316.220	367.607
38	119.775	171.138	186.065	202.372	212.695	221.604	231.564	237.935	253.601
39	97.023	133.934	147.611	164.974	177.737	190.247	206.440	218.449	256.941
40	112.828	149.159	161.069	175.075	184.619	193.387	203.921	211.167	231.433
41	83.196	117.419	128.828	142.386	151.720	160.372	170.872	178.170	198.958
42	116.237	172.308	191.863	215.760	232.677	248.734	268.761	283.069	325.905
43	116.642	163.418	179.303	198.398	211.695	224.140	239.413	250.149	281.358
44	109.966	160.258	178.279	200.679	216.805	232.331	252.020	266.322	310.460
45	116.372	171.431	190.365	213.304	229.402	244.569	263.325	276.611	315.774
46	74.148	88.400	91.927	95.428	97.440	99.039	100.668	101.614	103.591
47	109.966	160.258	178.279	200.679	216.805	232.331	252.020	266.322	310.460
48	94.734	128.776	139.530	151.891	160.124	167.543	176.260	182.123	197.874
49	119.775	171.138	186.065	202.372	212.695	221.604	231.564	237.935	253.601
50	103.329	140.043	151.529	164.654	173.345	181.136	190.237	196.324	212.505
51	94.100	134.498	148.192	164.633	176.070	186.763	199.871	209.074	235.774
52	90.439	126.504	139.277	155.038	166.303	177.083	190.656	200.445	230.262

Con'td									
53	108.429	156.673	173.748	194.807	209.852	224.243	242.354	255.411	295.148
54	64.589	84.574	92.150	101.907	109.182	116.400	125.875	133.001	156.445
55	89.306	127.760	141.424	158.320	170.421	182.021	196.655	207.231	239.565
56	82.105	104.156	111.062	118.960	124.193	128.888	134.375	138.048	147.824
57	101.839	133.641	143.348	154.273	161.399	167.707	174.966	179.749	192.134
58	98.009	137.150	150.141	165.536	176.106	185.880	197.710	205.911	229.155
59	90.439	126.504	139.277	155.038	166.303	177.083	190.656	200.445	230.262
60	120.047	164.234	179.034	196.673	208.852	220.169	233.942	243.542	271.029
61	120.047	164.234	179.034	196.673	208.852	220.169	233.942	243.542	271.029
62	119.748	168.037	185.065	206.020	220.957	235.217	253.123	266.003	305.046
63	119.872	161.370	171.129	180.527	185.767	189.828	193.842	196.106	200.604
64	144.550	215.939	241.246	272.491	294.835	316.227	343.175	362.622	421.918
65	128.460	184.629	202.362	222.737	236.304	248.526	262.878	272.530	298.440
66	83.004	116.819	129.332	145.204	156.862	168.280	183.048	193.990	229.013
67	90.571	111.715	117.691	124.112	128.109	131.510	135.250	137.603	143.224
68	90.183	121.777	132.914	146.615	156.378	165.698	177.397	185.811	211.302
69	124.039	186.390	208.161	234.788	253.652	271.567	293.929	309.917	357.849
70	115.966	157.019	170.723	187.022	198.252	208.668	221.320	230.120	255.224
71	92.796	132.843	146.095	161.772	172.516	182.436	194.420	202.713	226.144
72	80.016	108.602	118.876	131.671	140.900	149.800	161.107	169.336	194.819
73	80.016	108.602	118.876	131.671	140.900	149.800	161.107	169.336	194.819
74	143.464	223.100	251.314	286.134	311.027	334.850	364.851	386.493	452.438
75	151.684	235.763	264.334	298.691	322.625	345.033	372.544	391.890	448.165
76	85.792	124.581	138.318	155.266	167.380	178.970	193.562	204.086	236.137
77	116.237	172.308	191.863	215.760	232.677	248.734	268.761	283.069	325.905
78	149.041	205.721	219.546	233.149	240.900	247.018	253.194	256.754	264.081
79	129.881	181.517	197.015	214.282	225.428	235.210	246.356	253.625	272.117
80	92.532	133.323	148.579	168.060	182.463	196.651	215.121	228.898	273.526
81	100.828	148.478	164.549	183.783	197.121	209.559	224.760	235.400	266.096
82	122.258	178.551	198.422	222.889	240.341	257.010	277.955	293.030	338.776
83	103.710	143.484	158.007	176.273	189.577	202.516	219.113	231.310	269.759
84	155.162	244.733	276.351	315.284	343.053	369.578	402.907	426.896	499.693
85	104.446	145.791	160.520	178.762	191.848	204.409	220.280	231.769	266.993
86	122.587	152.428	160.107	167.907	172.495	176.216	180.090	182.395	187.398
87	95.531	133.022	145.249	159.584	169.322	178.244	188.930	196.259	216.640
88	122.157	168.129	183.011	200.375	212.115	222.830	235.604	244.326	268.380
89	86.153	106.319	111.881	117.769	121.380	124.414	127.703	129.742	134.491
90	112.577	145.658	155.382	166.078	172.896	178.815	185.476	189.767	200.442
91	99.304	138.977	151.585	166.130	175.854	184.644	195.007	202.004	220.922
92	104.413	144.372	157.836	173.941	185.101	195.503	208.208	217.097	242.710
93	143.145	213.169	238.019	268.722	290.693	311.740	338.272	357.432	415.923
94	108.429	156.673	173.748	194.807	209.852	224.243	242.354	255.411	295.148
95	123.317	173.778	189.740	208.102	220.342	231.380	244.357	253.094	276.597
96	138.551	206.778	230.458	259.311	279.677	298.957	322.935	340.016	390.882
97	119.436	172.655	190.512	211.817	226.545	240.241	256.929	268.574	301.979
98	101.636	146.813	161.926	179.922	192.338	203.866	217.885	227.650	255.566
99	116.237	172.308	191.863	215.760	232.677	248.734	268.761	283.069	325.905
100	87.711	118.651	129.609	143.130	152.794	162.042	173.685	182.083	207.662
101	90.183	121.777	132.914	146.615	156.378	165.698	177.397	185.811	211.302
102	106.990	155.526	170.933	188.697	200.565	211.286	223.920	232.443	255.462
103	106.990	155.526	170.933	188.697	200.565	211.286	223.920	232.443	255.462
104	128.460	184.629	202.362	222.737	236.304	248.526	262.878	272.530	298.440

Station No.	Estimated Rainfall Depths of GLADS 2-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	110.373	147.275	159.903	175.156	185.828	195.857	208.223	216.956	242.559
2	112.047	151.509	165.674	183.300	196.003	208.246	223.787	235.089	270.037
3	112.490	144.815	154.690	165.810	173.067	179.494	186.894	191.773	204.417
4	169.850	238.913	259.119	281.284	295.374	307.576	321.271	330.068	351.851
5	105.086	140.709	153.323	168.887	180.010	190.653	204.051	213.714	243.141
6	168.567	272.315	310.475	358.693	393.977	428.423	472.812	505.579	609.736
7	126.966	170.152	184.318	200.984	212.344	222.784	235.331	243.966	268.130
9	121.718	163.364	177.517	194.535	206.391	217.492	231.120	240.704	268.583
10	112.331	146.919	158.871	173.394	183.618	193.274	205.251	213.761	238.978
12	133.862	176.876	191.936	210.385	223.477	235.928	251.495	262.644	296.167
13	131.237	179.286	195.907	216.115	230.349	243.801	260.495	272.363	307.572
14	135.301	174.486	186.634	200.438	209.527	217.639	227.061	233.328	249.828
15	104.245	140.587	152.396	166.208	175.569	184.129	194.358	201.358	220.746
16	94.166	123.469	132.991	144.128	151.676	158.579	166.827	172.472	188.105
17	141.926	210.879	235.775	266.869	289.361	311.104	338.806	359.023	421.954
18	138.575	186.778	203.060	222.567	236.107	248.743	264.201	275.032	306.330
19	136.691	168.458	176.149	183.684	187.959	191.320	194.699	196.639	200.601
20	166.572	242.123	265.452	291.897	309.268	324.737	342.664	354.559	385.744
21	166.572	242.123	265.452	291.897	309.268	324.737	342.664	354.559	385.744
22	104.379	132.309	140.001	148.136	153.121	157.305	161.838	164.645	171.174
23	97.628	129.106	139.775	152.584	161.492	169.821	180.031	187.199	207.990
24	129.465	170.687	183.988	199.478	209.931	219.455	230.788	238.510	259.736
25	116.739	155.565	167.045	179.717	187.825	194.884	202.856	208.009	220.911
26	126.242	160.285	169.715	179.724	185.880	191.063	196.696	200.198	208.391
27	139.942	192.612	210.780	232.831	248.336	262.967	281.095	293.959	332.007
28	86.868	113.140	122.415	133.836	141.983	149.765	159.544	166.583	187.947
29	112.490	144.815	154.690	165.810	173.067	179.494	186.894	191.773	204.417
30	162.898	249.588	279.590	316.080	341.791	366.094	396.266	417.722	481.413
31	144.813	217.710	244.906	279.580	305.179	330.360	363.094	387.471	466.221
32	109.130	157.252	174.278	195.274	210.270	224.612	242.658	255.665	295.237
33	129.465	170.687	183.988	199.478	209.931	219.455	230.788	238.510	259.736
34	143.773	201.634	219.977	241.108	255.213	267.947	282.940	293.047	320.303
35	157.045	228.827	254.949	287.735	311.566	334.701	364.318	386.038	454.247
36	150.615	212.767	233.619	258.497	275.692	291.683	311.165	324.759	363.750
37	149.017	227.289	256.528	293.836	321.401	348.534	383.834	410.142	495.253
38	145.961	223.479	252.355	289.136	316.263	342.927	377.557	403.321	486.407
39	115.747	152.766	165.538	181.040	191.941	202.229	214.976	224.022	250.783
40	135.301	174.486	186.634	200.438	209.527	217.639	227.061	233.328	249.828
41	106.212	150.972	166.476	185.345	198.646	211.225	226.851	237.968	271.002
42	151.700	220.116	242.237	268.032	285.460	301.357	320.296	333.217	368.813
43	159.475	227.098	250.163	277.963	297.374	315.583	337.988	353.780	399.905
44	131.092	181.698	198.552	218.566	232.338	245.095	260.567	271.314	301.892
45	137.627	201.191	223.709	251.498	271.362	290.373	314.311	331.579	384.188

Con'td									
46	94.166	123.469	132.991	144.128	151.676	158.579	166.827	172.472	188.105
47	131.092	181.698	198.552	218.566	232.338	245.095	260.567	271.314	301.892
48	124.249	173.222	190.186	210.829	225.382	239.145	256.240	268.403	304.543
49	145.961	223.479	252.355	289.136	316.263	342.927	377.557	403.321	486.407
51	116.128	162.271	177.560	195.660	208.075	219.545	233.413	243.016	270.188
52	112.047	151.509	165.674	183.300	196.003	208.246	223.787	235.089	270.037
53	145.087	213.846	238.708	269.787	292.288	314.057	341.815	362.092	425.311
54	86.868	113.140	122.415	133.836	141.983	149.765	159.544	166.583	187.947
56	105.086	140.709	153.323	168.887	180.010	190.653	204.051	213.714	243.141
57	127.317	160.897	170.326	180.414	186.669	191.972	197.781	201.421	210.058
58	114.464	151.585	163.077	176.124	184.707	192.361	201.244	207.147	222.666
59	112.047	151.509	165.674	183.300	196.003	208.246	223.787	235.089	270.037
60	147.266	200.560	220.404	245.671	264.302	282.609	306.379	324.058	381.040
62	149.176	205.799	225.702	250.146	267.535	284.109	304.880	319.791	364.830
63	145.138	218.363	244.227	276.087	298.821	320.543	347.848	367.509	427.213
65	166.572	242.123	265.452	291.897	309.268	324.737	342.664	354.559	385.744
66	104.927	141.636	155.249	172.541	185.259	197.730	213.882	225.866	264.318
67	115.807	152.678	164.337	177.747	186.685	194.743	204.216	210.592	227.739
68	112.331	146.919	158.871	173.394	183.618	193.274	205.251	213.761	238.978
69	162.898	249.588	279.590	316.080	341.791	366.094	396.266	417.722	481.413
70	140.936	185.242	199.102	214.938	225.423	234.823	245.802	253.144	272.660
71	116.409	162.962	177.598	194.373	205.514	215.529	227.261	235.131	256.163
72	102.187	135.119	145.655	157.861	166.055	173.488	182.287	188.252	204.498
73	102.187	135.119	145.655	157.861	166.055	173.488	182.287	188.252	204.498
74	178.786	279.115	313.610	355.394	384.715	412.336	446.490	470.680	541.966
77	151.700	220.116	242.237	268.032	285.460	301.357	320.296	333.217	368.813
78	176.236	273.066	307.322	349.563	379.733	408.585	444.888	471.054	550.653
79	169.850	238.913	259.119	281.284	295.374	307.576	321.271	330.068	351.851
80	118.369	168.109	184.806	204.732	218.510	231.326	246.946	257.848	289.137
81	128.616	190.738	213.509	242.221	263.185	283.615	309.886	329.238	390.512
82	144.925	206.627	228.322	254.970	273.931	292.005	314.661	330.928	380.076
83	124.451	165.503	179.490	196.335	208.089	219.108	232.658	242.202	270.042
85	124.106	169.168	185.255	205.204	219.533	233.303	250.724	263.350	302.155
86	152.966	190.498	201.071	212.409	219.452	225.434	232.000	236.124	245.940
87	110.277	148.761	161.457	176.448	186.704	196.157	207.558	215.432	237.607
88	150.537	206.436	224.856	246.590	261.446	275.133	291.626	303.010	335.025
89	109.030	147.354	160.600	176.698	188.030	198.735	212.015	221.450	249.418
90	143.156	181.800	193.137	205.594	213.526	220.404	228.137	233.112	245.466
91	121.566	164.335	176.877	190.654	199.423	207.026	215.571	221.068	234.710
92	131.758	170.244	181.137	192.849	200.146	206.358	213.195	217.500	227.798
94	145.087	213.846	238.708	269.787	292.288	314.057	341.815	362.092	425.311
95	136.238	192.992	211.968	234.559	250.141	264.606	282.192	294.438	329.430
96	171.665	253.536	282.022	316.784	341.357	364.652	393.665	414.365	476.176
97	142.319	207.228	230.711	260.077	281.345	301.926	328.180	347.364	407.212
98	130.624	192.730	213.269	237.554	254.192	269.548	288.093	300.920	337.135
99	151.700	220.116	242.237	268.032	285.460	301.357	320.296	333.217	368.813
100	107.733	147.374	161.874	180.131	193.444	206.403	223.045	235.288	273.959
102	134.089	201.656	225.895	256.046	277.767	298.694	325.251	344.555	404.209
103	134.089	201.656	225.895	256.046	277.767	298.694	325.251	344.555	404.209
104	166.572	242.123	265.452	291.897	309.268	324.737	342.664	354.559	385.744

Station No.	Estimated Rainfall Depths of GLADS 3-day duration for the indicated frequency (Years)								
	2	10	20	50	100	200	500	1000	10000
1	123.930	163.380	176.949	193.390	204.929	215.802	229.250	238.777	266.865
2	127.577	168.981	182.602	198.657	209.621	219.713	231.863	240.240	263.759
3	120.324	156.633	170.334	187.928	201.009	213.954	230.902	243.611	285.203
4	179.428	239.890	256.476	273.977	284.677	293.642	303.329	309.316	323.185
5	123.302	154.169	163.104	172.843	178.993	184.290	190.198	193.968	203.200
6	181.030	289.120	329.475	380.949	418.966	456.378	505.032	541.281	658.476
7	137.963	181.469	195.610	212.152	223.365	233.620	245.877	254.266	277.508
9	135.914	185.268	202.750	224.323	239.743	254.500	273.081	286.484	327.313
10	123.613	158.177	169.557	182.978	192.147	200.591	210.762	217.778	237.493
12	148.958	199.299	217.937	241.585	258.959	275.981	298.003	314.326	366.597
13	145.541	198.152	216.855	239.986	256.557	272.444	292.493	306.985	351.313
14	146.325	195.337	213.846	237.627	255.316	272.830	295.769	312.981	369.358
15	115.175	159.467	175.704	196.177	211.126	225.694	244.429	258.230	301.931
16	112.816	134.436	139.653	144.755	147.644	149.912	152.188	153.491	156.146
17	148.776	212.560	235.383	263.727	284.115	303.729	328.582	346.619	402.196
18	148.338	206.487	227.085	252.505	270.675	288.063	309.959	325.753	373.869
19	141.141	187.619	202.433	219.556	231.024	241.406	253.669	261.964	284.462
20	175.520	249.176	272.594	299.618	317.689	334.028	353.298	366.311	401.513
21	175.520	249.176	272.594	299.618	317.689	334.028	353.298	366.311	401.513
22	111.054	154.888	171.495	192.874	208.809	224.614	245.355	260.948	312.213
23	114.142	140.184	147.271	154.714	159.243	163.022	167.086	169.586	175.331
24	140.578	188.622	206.447	229.094	245.754	262.095	283.264	298.975	349.408
25	121.225	160.379	172.561	186.434	195.590	203.774	213.303	219.654	236.440
26	128.819	163.501	173.663	184.822	191.921	198.074	204.986	209.429	220.451
27	147.599	209.290	232.410	261.974	283.861	305.444	333.581	354.593	422.828
28	102.959	130.050	138.807	149.015	155.911	162.200	169.691	174.801	188.873
29	120.324	156.633	170.334	187.928	201.009	213.954	230.902	243.611	285.203
30	178.117	269.489	298.995	333.373	356.583	377.739	402.924	420.094	467.327
31	148.908	207.665	228.479	254.165	272.526	290.096	312.221	328.181	376.801
32	123.179	177.046	196.131	219.686	236.526	252.643	272.940	287.582	332.201
33	140.578	188.622	206.447	229.094	245.754	262.095	283.264	298.975	349.408
34	159.924	225.384	246.257	270.388	286.553	301.191	318.485	330.185	361.932
35	170.973	234.910	255.348	279.012	294.889	309.284	326.317	337.857	369.258
36	160.427	215.247	232.130	251.238	263.768	274.912	287.806	296.347	318.677
37	158.457	244.491	276.792	318.141	348.788	379.037	418.514	448.028	544.065
38	154.343	224.771	249.507	279.871	301.461	322.029	347.794	366.281	422.070
39	130.668	169.937	183.552	200.131	211.825	222.889	236.641	246.431	275.551
40	146.325	195.337	213.846	237.627	255.316	272.830	295.769	312.981	369.358
41	112.278	154.221	168.938	186.990	199.818	212.032	227.323	238.287	271.336
42	158.543	221.665	242.178	266.172	282.435	297.308	315.081	327.244	360.937
43	168.936	224.283	240.976	259.628	271.706	282.330	294.472	302.414	322.722
44	146.097	208.598	231.692	260.955	282.428	303.443	330.598	350.700	414.925
45	154.122	223.511	248.613	280.003	302.735	324.734	352.793	373.297	437.256

Con'td									
46	112.816	134.436	139.653	144.755	147.644	149.912	152.188	153.491	156.146
47	146.097	208.598	231.692	260.955	282.428	303.443	330.598	350.700	414.925
48	127.523	162.657	173.610	186.098	194.350	201.734	210.341	216.085	231.297
49	154.343	224.771	249.507	279.871	301.461	322.029	347.794	366.281	422.070
51	123.690	168.511	183.354	200.920	212.964	224.088	237.534	246.842	273.161
52	127.577	168.981	182.602	198.657	209.621	219.713	231.863	240.240	263.759
53	156.541	214.945	234.023	256.411	271.632	285.590	302.322	313.809	345.808
54	102.959	130.050	138.807	149.015	155.911	162.200	169.691	174.801	188.873
56	123.302	154.169	163.104	172.843	178.993	184.290	190.198	193.968	203.200
57	139.446	185.088	200.687	219.513	232.675	245.034	260.262	271.008	302.468
58	129.080	175.158	190.877	209.824	223.055	235.467	250.742	261.509	292.963
59	127.577	168.981	182.602	198.657	209.621	219.713	231.863	240.240	263.759
60	162.430	228.413	252.506	282.808	304.881	326.346	353.882	374.118	437.907
62	161.259	230.799	256.636	289.493	313.687	337.435	368.228	391.101	464.646
63	155.742	222.348	243.842	268.876	285.769	301.163	319.481	331.964	366.281
65	175.520	249.176	272.594	299.618	317.689	334.028	353.298	366.311	401.513
66	120.084	159.607	172.905	188.797	199.801	210.050	222.557	231.299	256.453
67	123.282	156.050	166.374	178.222	186.101	193.190	201.507	207.092	222.053
68	123.613	158.177	169.557	182.978	192.147	200.591	210.762	217.778	237.493
69	178.117	269.489	298.995	333.373	356.583	377.739	402.924	420.094	467.327
70	155.330	208.815	227.502	250.363	266.566	281.958	301.177	314.923	356.159
71	122.048	169.292	184.902	203.351	215.983	227.637	241.705	251.430	278.861
72	118.304	156.570	169.315	184.449	194.863	204.509	216.209	224.336	247.459
73	118.304	156.570	169.315	184.449	194.863	204.509	216.209	224.336	247.459
74	190.507	294.263	330.853	375.884	407.983	438.630	477.115	504.800	588.724
77	158.543	221.665	242.178	266.172	282.435	297.308	315.081	327.244	360.937
78	186.313	283.773	317.610	358.846	387.957	415.522	449.809	474.238	547.012
79	179.428	239.890	256.476	273.977	284.677	293.642	303.329	309.316	323.185
80	127.192	177.624	195.492	217.545	233.310	248.398	267.399	281.107	322.875
81	138.854	194.288	212.823	234.889	250.110	264.239	281.416	293.378	327.559
82	164.340	237.891	263.640	295.184	317.568	338.855	365.470	384.529	441.836
83	138.224	183.968	200.062	219.839	233.915	247.338	264.169	276.259	312.811
85	140.040	187.683	204.562	225.395	240.288	254.542	272.492	285.441	324.899
86	161.147	199.910	211.020	223.055	230.611	237.084	244.263	248.817	259.853
87	124.672	164.051	176.740	191.505	201.461	210.525	221.302	228.639	248.778
88	148.509	202.491	221.616	245.219	262.093	278.242	298.579	313.250	357.953
89	119.805	149.534	158.264	167.863	173.978	179.285	185.253	189.096	198.648
90	150.816	187.990	198.763	210.513	217.939	224.338	231.481	236.042	247.226
91	138.663	197.938	217.066	239.342	254.375	268.073	284.372	295.479	326.011
92	138.819	187.235	204.347	225.436	240.490	254.880	272.975	286.009	325.622
94	156.541	214.945	234.023	256.411	271.632	285.590	302.322	313.809	345.808
95	171.936	237.718	257.857	280.565	295.403	308.558	323.725	333.736	359.741
96	183.678	280.848	316.383	361.121	393.740	425.488	466.253	496.239	590.930
97	162.440	235.822	260.468	289.891	310.240	329.175	352.257	368.373	414.653
98	138.888	199.129	219.848	244.951	262.569	279.170	299.700	314.244	357.120
99	158.543	221.665	242.178	266.172	282.435	297.308	315.081	327.244	360.937
100	125.782	167.305	182.064	200.317	213.391	225.926	241.743	253.175	288.138
102	137.744	203.669	228.740	261.094	285.267	309.291	340.894	364.708	443.346
103	137.744	203.669	228.740	261.094	285.267	309.291	340.894	364.708	443.346
104	175.520	249.176	272.594	299.618	317.689	334.028	353.298	366.311	401.513

APPENDIX F: Frequency Factor K Values for in situ and Reanalysis Data

Frequency factor (K) for 1-day duration					Frequency factor (K) for 2-day duration				
Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS	Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS
	K	K	K	K		K	K	K	K
1	1.757	3.550	2.650	3.770	1	2.352	4.721	3.010	2.784
2	2.429	2.953	3.301	3.545	2	2.090	2.866	3.672	3.282
3	4.987	3.452	3.461	3.226	3	3.465	4.397	2.840	2.127
4	2.357	1.832	1.778	5.850	4	2.750	2.055	2.736	5.771
5	8.314	3.841	3.630	2.418	5	2.439	3.677	2.447	4.057
6	3.348	2.361	2.265	2.602	6	2.947	4.890	2.224	2.449
7	3.424	3.309	2.942	2.547	7	2.121	4.572	4.451	2.698
8	2.011	2.580	2.816	4.105	9	3.115	8.523	4.764	2.682
9	4.301	8.008	4.308	3.302	10	1.943	3.207	3.535	3.092
10	4.336	3.139	2.482	3.210	12	4.399	3.334	3.185	3.298
11	2.632	3.139	2.482	3.210	13	2.257	3.428	3.287	3.416
12	7.755	3.918	2.977	3.268	14	3.663	2.913	3.302	2.338
13	2.253	4.186	3.806	2.749	15	3.333	2.750	8.859	2.410
14	4.042	3.356	3.576	2.918	16	3.464	4.185	3.610	2.738
15	2.464	2.456	9.187	3.696	17	2.650	2.389	2.993	2.859
16	3.093	4.324	4.141	1.754	18	5.708	7.548	7.160	4.500
17	3.480	5.059	5.700	2.585	19	2.815	3.428	3.287	2.262
18	4.010	7.093	6.187	3.635	20	2.554	2.055	2.736	5.189
19	3.210	4.186	3.806	2.850	21	2.757	2.055	2.736	5.189
20	1.646	1.832	1.778	5.232	22	4.852	2.750	8.859	1.972
21	1.786	1.832	1.778	5.232	23	2.916	4.644	3.683	2.859
22	4.682	2.456	9.187	3.056	24	5.369	2.865	2.981	2.391
23	2.168	3.611	3.261	1.877	25	2.496	4.353	6.449	2.120
24	4.796	4.132	3.902	2.642	26	7.571	2.419	4.405	2.045
25	4.352	5.075	7.627	2.170	27	4.110	7.548	7.160	3.989
26	9.851	2.486	5.315	2.079	28	2.952	3.636	2.735	4.295
27	3.590	7.093	6.187	2.662	29	2.123	4.397	2.840	2.127
28	2.153	2.863	3.013	3.203	30	2.626	5.264	7.271	4.070
29	2.168	3.452	3.461	3.226	31	2.282	2.884	3.572	3.253
30	2.546	6.067	6.007	4.251	32	2.959	4.186	5.147	2.927
31	2.827	2.354	5.975	2.804	33	6.480	2.865	2.981	2.391
32	2.834	4.526	4.873	3.315	34	3.959	3.471	3.275	2.846
33	4.865	4.132	3.902	2.642	35	2.721	2.098	2.439	3.164
34	4.184	3.805	2.394	2.311	36	8.326	2.098	2.439	2.826
35	3.532	3.554	1.663	3.089	37	2.777	4.186	5.147	2.994
36	10.555	3.554	1.663	2.882	38	3.544	2.462	3.299	3.659
37	4.533	4.526	4.873	3.970	39	2.301	2.935	3.405	2.707
38	3.502	2.109	3.079	5.810	40	2.260	2.865	2.981	2.338

Frequency factor (K) for 1-day duration					Frequency factor (K) for 2-day duration				
Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS	Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS
	K	K	K	K		K	K	K	K
39	2.747	2.875	3.156	3.845	41	2.694	2.866	3.672	3.067
40	2.489	4.132	3.902	2.918	42	7.397	6.555	4.838	4.882
41	3.211	2.953	3.301	4.964	43	3.018	2.098	2.439	2.752
42	6.174	6.019	4.164	4.459	44	4.178	4.515	3.196	2.128
43	3.128	3.554	1.663	2.771	45	2.696	4.713	3.376	3.981
44	3.362	3.45	3.951	3.038	46	1.99	4.644	3.683	2.738
45	2.977	5.834	3.935	2.842	47	2.555	4.515	3.196	2.128
46	2.716	3.611	3.261	1.754	48	3.369	2.805	2.339	3.352
47	3.431	3.45	3.951	3.038	49	2.958	2.462	3.299	3.659
48	2.634	1.895	3.8	3.142	51	2.656	6.095	2.735	2.689
49	3.429	2.109	3.079	5.81	52	2.344	2.866	3.672	3.282
50	2.092	1.843	3.183	2.243	53	2.169	2.389	2.993	3.003
51	3.037	2.369	2.361	2.882	54	4.777	3.636	2.735	4.295
52	3.364	2.953	3.301	3.545	56	2.503	3.677	2.447	4.057
53	2.617	5.059	5.7	2.87	57	2.362	4.015	2.904	1.823
54	3.307	2.863	3.013	3.203	58	3.467	4.721	3.01	1.959
55	1.16	2.369	2.361	3.003	59	2.544	2.866	3.672	3.282
56	6.23	3.841	3.63	2.418	60	1.953	8.523	4.764	3.012
57	1.913	3.433	4.071	2.597	62	3.053	8.523	4.764	3.685
58	4.75	3.55	2.65	2.501	63	2.027	3.429	3.172	4.235
59	2.744	2.953	3.301	3.545	65	2.834	6.152	5.412	5.189
60	2.696	8.008	4.308	2.936	66	2.586	4.117	3.415	3.739
61	3.115	8.008	4.308	2.936	67	2.377	4.644	3.683	2.292
62	2.826	8.008	4.308	2.901	68	6.187	4.117	3.415	3.092
63	4.908	2.862	3.1	6.558	69	2.006	5.264	7.271	4.07
64	3.616	6.055	7.426	2.469	70	2.851	4.185	3.61	2.215
65	3.921	6.146	5.991	5.232	71	2.273	6.138	2.224	2.533
66	2.727	5.046	3.186	2.598	72	3.322	4.644	3.683	2.744
67	2.376	3.611	3.261	2.405	73	2.498	4.644	3.683	2.744
68	7.248	5.046	3.186	3.21	74	2.661	5.945	7.55	4.261
69	2.293	6.067	6.007	4.251	77	3.215	2.884	3.572	4.882
70	2.763	4.324	4.141	2.636	78	6.706	2.98	2.592	4.078
71	2.715	2.361	2.265	2.753	79	2.173	2.055	2.736	5.771
72	2.586	3.611	3.261	2.76	80	4.287	2.826	4.263	4.813
73	2.705	3.611	3.261	2.76	81	3.024	3.429	3.172	3.33
74	2.708	7.998	6.67	3.715	82	3.329	2.089	5.667	2.849
75	2.799	5.691	7.926	4.41	83	4.754	2.913	3.302	3.204
76	4.005	2.367	8.494	3.264	85	2.844	2.913	3.302	3.329
77	2.028	2.354	5.975	4.459	86	1.818	2.032	2.263	2.615
78	2.403	2.44	2.991	6.367	87	2.521	4.721	3.01	2.32
79	2.487	1.832	1.778	5.85	88	7.574	2.826	4.263	2.745
80	4.609	2.861	6.622	3.267	89	5.357	4.644	3.683	2.514
81	2.531	2.862	3.1	4.736	90	4.103	3.362	2.341	2.963
82	4.115	3.052	7.2	4.185	91	2.208	4.311	2.18	2.146
83	3.952	3.356	3.576	3.479	92	2.281	3.428	3.287	2.973

Frequency factor (K) for 1-day duration					Frequency factor (K) for 2-day duration				
Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS	Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS
	K	K	K	K		K	K	K	K
83	3.952	3.356	3.576	3.479	92	2.281	3.428	3.287	2.973
84	4.811	2.58	2.816	4.105	94	6.141	2.389	2.993	3.003
85	3.036	3.356	3.576	3.37	95	2.281	2.055	2.736	2.367
86	2.17	2.609	3.085	1.917	96	2.485	5.378	9.577	3.086
87	2.438	3.55	2.65	2.513	97	1.147	2.089	5.667	3.073
88	3.938	2.861	6.622	2.361	98	2.757	6.152	5.412	3.557
89	3.357	3.611	3.261	2.303	99	1.291	2.884	3.572	4.882
90	3.357	3.466	2.841	2.309	100	2.064	3.677	2.447	2.894
91	1.763	2.742	3.887	2.542	102	3.245	2.462	3.299	3.246
92	2.661	4.186	3.806	2.79	103	4.962	2.866	3.672	3.246
93	2.708	6.055	7.426	2.65	104	2.683	2.055	2.736	5.189
94	4.087	5.059	5.7	2.87					
95	2.344	1.832	1.778	5.708					
96	5.956	5.691	7.926	2.483					
97	3.35	3.052	7.2	4.956					
98	2.213	6.146	5.991	3.618					
99	6.435	2.354	5.975	4.459					
100	2.7	3.841	3.63	2.82					
101	5.457	2.109	3.079	3.21					
102	3.946	2.109	3.079	5.273					
103	2.395	1.832	3.301	5.273					
104	4.172	2.953	1.778	5.232					

Frequency factor (K) for 3-day duration					Frequency factor (K) for 3-day duration				
Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS	Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS
	K	K	K	K		K	K	K	K
1	2.828	5.064	2.735	5.113	51	2.684	5.118	2.595	2.587
2	1.61	2.985	2.733	2.488	52	2.682	2.985	2.733	2.488
3	2.515	4.592	2.876	3.943	53	3.334	3.624	3.958	2.958
4	2.388	2.439	3.049	6.008	54	4.28	3.483	2.308	2.256
5	2.203	3.273	3.211	1.95	56	2.737	3.273	3.211	1.95
6	2.625	4.528	2.067	2.478	57	1.97	2.54	5.634	2.472
7	3.003	3.61	2.958	2.379	58	3.359	5.064	2.735	2.932
9	3.575	8.432	5.348	3.091	59	2.555	2.985	2.733	2.488
10	3.1	2.615	3.656	2.392	60	1.971	8.432	5.348	2.836
12	1.486	3.048	2.741	3.494	62	2.476	8.432	5.348	2.632
13	2.386	3.75	3.269	2.965	63	2.618	3.59	2.244	5.089
14	2.348	3.161	3.051	3.306	65	3.084	7.158	5.726	5.187
15	4.554	2.577	7.201	3.763	66	2.388	3.884	4.073	2.835
16	3.22	3.899	3.344	1.635	67	2.363	3.115	2.717	2.387

Frequency factor (K) for 3-day duration					Frequency factor (K) for 3-day duration				
Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS	Station No.	In-situ	ECMWF	ECMWF Corr.	GLADS
17	3.19	3.624	3.958	2.856	68	9.002	3.884	4.073	2.392
18	5.719	7.023	6.379	3.365	69	1.862	5.79	10.762	3.229
19	2.086	3.75	3.269	3.188	70	2.929	3.899	3.344	2.731
20	2.446	2.439	3.049	5.187	71	2.012	4.528	2.067	2.444
21	2.571	2.439	3.049	5.187	72	2.665	3.115	2.717	2.671
22	2.979	2.577	7.201	4.211	73	2.288	3.115	2.717	2.671
23	1.794	3.115	2.717	2.026	74	2.607	5.857	5.54	3.833
24	5.357	2.81	2.765	2.805	77	3.963	2.232	2.853	5.201
25	2.209	2.918	6.953	2.391	78	8.187	3.753	4.08	4.348
26	6.666	2.027	3.628	2.302	79	2.616	2.439	3.049	6.008
27	4.205	7.023	6.379	2.618	80	2.851	2.67	2.816	3.214
28	2.933	3.483	2.308	2.256	81	2.633	3.59	2.244	4.637
29	1.919	4.592	2.876	3.943	82	2.683	3.286	5.033	4.243
30	2.438	5.79	10.762	3.229	83	3.974	3.161	3.051	4.096
31	2.508	2.165	2.853	3.917	85	2.951	3.161	3.051	3.973
32	2.898	4.646	5.276	3.432	86	2.34	2.013	2.733	1.965
33	4.656	2.81	2.765	2.805	87	3.47	5.064	2.735	3.302
34	4.875	2.549	2.31	2.136	88	6.127	2.67	2.816	3.3
35	2.814	2.426	2.327	2.877	89	3.08	3.115	2.717	2.046
36	7.979	2.423	2.327	2.783	90	2.825	2.391	1.985	2.173
37	2.302	4.646	5.276	3.222	91	1.123	4.032	2.323	2.196
38	3.921	2.766	3.255	4.33	92	2.582	3.75	3.269	3.183
39	1.831	4.313	2.344	4.938	94	6.533	3.624	3.958	2.958
40	2.27	2.81	2.765	3.306	95	2.828	2.439	3.049	5.237
41	3.774	2.985	2.733	3.445	96	1.968	6.205	3.172	2.404
42	6.876	6.462	5.113	5.201	97	2.162	3.286	5.033	4.565
43	3.59	2.426	2.327	2.788	98	2.571	7.158	2.327	3.499
44	4.183	4.965	2.545	3.417	99	1.808	2.232	2.853	5.201
45	2.796	4.102	3.115	3.232	100	2.189	3.273	3.211	2.467
46	2.564	3.115	2.717	1.635	102	3.948	2.766	3.255	3.76
47	2.523	4.965	2.545	3.417	103	3.521	2.985	2.733	3.76
48	4.234	2.687	2.97	2.45	104	1.662	2.439	3.049	5.187
49	4.066	2.766	3.255	4.33					

APPENDIX G: Probable Maximum Precipitations (PMP) of Different Stations in the UBNB and the Ratios of PMP to 10,000 Years Return Period Quantiles for in situ and Reanalysis data.

Table G.1 Probable Maximum Precipitations (PMP) of different stations in the UBNB and the ratios of PMP to 10,000 years return period quantiles for 1-day.

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
1	319.336	150.617	2.120	320.100	226.825	1.411	161.649	97.448	1.659	279.950	246.113	1.137
2	257.503	140.243	1.836	191.203	130.701	1.463	119.882	79.894	1.501	277.251	230.262	1.204
3	312.044	250.572	1.245	282.477	199.491	1.416	136.725	99.208	1.378	261.034	200.571	1.301
4	257.889	163.117	1.581	211.369	100.000	2.114	112.657	49.132	2.293	372.176	272.117	1.368
5	199.377	86.233	2.312	211.081	152.142	1.387	106.687	71.907	1.484	224.200	147.824	1.517
6	314.155	252.733	1.243	123.581	82.239	1.503	69.987	44.831	1.561	566.296	496.681	1.140
7	228.901	133.560	1.714	189.677	147.667	1.284	94.413	79.425	1.189	302.488	202.305	1.495
8	219.857	72.731	3.023	262.644	158.259	1.660	198.525	125.246	1.585	586.421	499.693	1.174
9	271.421	189.926	1.429	210.447	92.878	2.266	162.474	90.666	1.792	279.785	240.122	1.165
10	174.142	134.756	1.292	148.032	120.111	1.232	101.953	68.216	1.495	262.476	211.302	1.242
11	200.194	131.123	1.527	148.032	120.111	1.232	101.953	68.216	1.495	262.476	211.302	1.242
12	262.712	315.722	0.832	231.781	162.774	1.424	157.160	100.861	1.558	322.499	255.815	1.261
13	257.180	154.172	1.668	229.509	160.473	1.430	135.663	90.844	1.493	348.233	271.748	1.281
14	226.106	195.092	1.159	245.759	169.479	1.450	132.835	87.315	1.521	327.173	231.433	1.414
15	320.737	230.976	1.389	334.556	259.693	1.288	151.845	56.398	2.692	258.723	213.492	1.212
16	290.884	148.264	1.962	203.181	127.313	1.596	117.452	72.609	1.618	198.212	103.591	1.913
17	292.398	276.461	1.058	161.035	124.232	1.296	91.876	60.413	1.521	386.258	285.759	1.352
18	236.855	157.885	1.500	234.901	111.733	2.102	129.379	69.038	1.874	318.366	284.750	1.118
19	236.357	152.707	1.548	231.311	160.473	1.441	136.784	90.844	1.506	334.881	199.672	1.677
20	313.455	162.455	1.929	211.369	100.000	2.114	112.657	48.292	2.333	394.979	298.440	1.323
21	367.721	143.931	2.555	211.369	100.000	2.114	112.657	56.398	1.998	394.979	298.440	1.323
22	395.145	366.603	1.078	336.275	259.693	1.295	152.868	56.398	2.711	270.603	242.849	1.114
23	214.802	108.859	1.973	173.387	121.412	1.428	101.673	67.674	1.502	205.449	105.445	1.948
24	205.315	169.892	1.209	233.120	158.294	1.473	117.748	68.516	1.719	317.996	222.563	1.429
25	245.957	206.286	1.192	204.036	147.485	1.383	120.109	53.965	2.226	267.569	158.839	1.685
26	328.176	516.964	0.635	182.035	95.086	1.914	120.476	68.258	1.765	279.819	143.596	1.949
27	283.186	171.399	1.652	234.901	111.733	2.102	129.379	69.038	1.874	354.291	275.125	1.288

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
28	196.582	118.204	1.663	273.248	214.142	1.276	143.897	90.744	1.586	170.877	156.445	1.092
29	214.802	108.859	1.973	282.477	199.491	1.416	136.725	99.208	1.378	261.034	200.571	1.301
30	214.653	98.899	2.170	230.852	97.574	2.366	268.427	84.083	3.192	424.041	357.849	1.185
31	192.572	104.724	1.839	215.705	114.289	1.887	123.077	69.289	1.776	422.705	298.755	1.415
32	521.002	284.010	1.834	229.939	159.188	1.444	162.691	93.538	1.739	276.649	224.288	1.233
33	223.720	196.692	1.137	233.120	158.294	1.473	117.748	68.516	1.719	317.996	222.563	1.429
34	186.702	165.636	1.127	109.888	93.282	1.178	78.037	63.102	1.237	415.403	254.240	1.634
35	163.393	89.817	1.819	177.704	121.434	1.463	92.020	45.194	2.036	385.933	326.453	1.182
36	211.781	322.732	0.656	177.704	121.434	1.463	92.020	45.194	2.036	352.520	250.759	1.406
37	238.105	219.703	1.084	229.939	159.188	1.444	162.691	93.538	1.739	437.401	367.607	1.190
38	200.232	270.018	0.742	172.076	101.958	1.688	117.551	80.646	1.458	365.441	253.601	1.441
39	339.901	169.214	2.009	303.049	235.026	1.289	162.906	120.298	1.354	280.304	256.941	1.091
40	252.804	120.970	2.090	233.120	158.294	1.473	117.748	68.516	1.719	327.173	231.433	1.414
41	272.378	226.202	1.204	191.203	130.701	1.463	119.882	79.894	1.501	244.405	198.958	1.228
42	451.206	459.511	0.982	210.361	125.957	1.670	133.521	73.566	1.815	380.575	325.905	1.168
43	238.265	195.024	1.222	177.704	121.434	1.463	92.020	47.493	1.938	383.913	281.358	1.365
44	472.544	312.084	1.514	322.914	226.979	1.423	163.180	107.062	1.524	378.546	310.460	1.219
45	302.398	189.592	1.595	134.012	106.651	1.257	101.681	67.803	1.500	421.657	315.774	1.335
46	146.590	92.175	1.590	173.387	121.412	1.428	101.673	67.674	1.502	198.212	103.591	1.913
47	266.241	166.678	1.597	322.914	226.979	1.423	163.180	107.062	1.524	378.546	310.460	1.219
48	257.191	148.262	1.735	174.201	83.434	2.088	132.015	82.164	1.607	295.138	197.874	1.492
49	284.206	183.264	1.551	172.076	101.958	1.688	117.551	80.646	1.458	365.441	253.601	1.441
50	370.291	145.284	2.549	178.848	88.225	2.027	125.461	81.668	1.536	334.622	212.505	1.575
51	234.994	212.235	1.107	165.838	96.564	1.717	111.092	61.818	1.797	321.552	235.774	1.364
52	188.420	89.629	2.102	191.203	130.701	1.463	119.882	79.894	1.501	277.251	230.262	1.204
53	196.003	86.103	2.276	161.035	124.232	1.296	91.876	60.413	1.521	371.713	295.148	1.259
54	185.635	107.758	1.723	273.248	214.142	1.276	143.897	90.744	1.586	170.877	156.445	1.092
55	102.966	62.628	1.644	165.838	96.564	1.717	111.092	73.196	1.518	297.163	239.565	1.240
56	188.275	184.894	1.018	211.081	152.142	1.387	106.687	71.907	1.484	224.200	147.824	1.517
57	293.580	129.755	2.263	176.392	138.822	1.271	114.112	73.260	1.558	304.865	192.134	1.587
58	276.072	235.526	1.172	320.100	226.825	1.411	161.649	97.448	1.659	331.187	229.155	1.445
59	221.825	236.578	0.938	191.203	130.701	1.463	119.882	79.894	1.501	277.251	230.262	1.204
60	210.354	107.279	1.961	210.447	92.878	2.266	162.474	90.666	1.792	374.234	271.029	1.381

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
61	272.807	141.609	1.926	210.447	92.878	2.266	162.474	90.666	1.792	374.234	271.029	1.381
62	208.575	130.900	1.593	210.447	92.878	2.266	162.474	90.666	1.792	386.371	305.046	1.267
63	282.893	212.251	1.333	171.260	114.564	1.495	107.747	71.986	1.497	345.545	200.604	1.723
64	154.047	100.415	1.534	253.475	124.044	2.043	249.573	74.239	3.362	544.945	421.918	1.292
65	378.003	287.085	1.317	194.849	112.227	1.736	98.777	56.801	1.739	394.979	298.440	1.323
66	170.675	82.146	2.078	155.337	117.638	1.320	126.681	78.058	1.623	267.980	229.013	1.170
67	198.094	108.079	1.833	173.387	121.412	1.428	101.673	67.674	1.502	240.999	143.224	1.683
68	281.912	313.560	0.899	155.337	117.638	1.320	126.681	78.058	1.623	262.476	211.302	1.242
69	265.178	156.235	1.697	230.852	97.574	2.366	268.427	84.083	3.192	424.041	357.849	1.185
70	258.870	230.988	1.121	203.181	127.313	1.596	117.452	72.609	1.618	358.257	255.224	1.404
71	270.349	153.035	1.767	123.581	82.239	1.503	69.987	40.628	1.723	324.176	226.144	1.433
72	251.020	153.957	1.630	173.387	121.412	1.428	101.673	67.674	1.502	238.633	194.819	1.225
73	233.343	157.860	1.478	173.387	121.412	1.428	101.673	67.674	1.502	238.633	194.819	1.225
74	176.710	87.174	2.027	153.169	77.868	1.967	145.092	87.964	1.649	541.358	452.438	1.197
75	103.633	49.609	2.089	213.199	126.285	1.688	196.805	64.114	3.070	553.495	448.165	1.235
76	480.405	365.240	1.315	299.199	193.072	1.550	146.355	58.238	2.513	290.247	236.137	1.229
77	300.166	176.776	1.698	215.705	114.289	1.887	123.077	69.289	1.776	380.575	325.905	1.168
78	202.236	113.743	1.778	157.189	79.656	1.973	134.652	86.760	1.552	448.785	264.081	1.699
79	228.723	147.680	1.549	211.369	100.000	2.114	112.657	49.132	2.293	372.176	272.117	1.368
80	263.035	185.816	1.416	202.211	122.069	1.657	116.570	58.530	1.992	301.006	273.526	1.100
81	218.665	135.927	1.609	171.260	114.564	1.495	107.747	71.986	1.497	323.748	266.096	1.217
82	261.441	197.704	1.322	339.413	255.830	1.327	158.974	67.742	2.347	392.433	338.776	1.158
83	306.098	247.874	1.235	245.759	169.479	1.450	132.835	87.315	1.521	309.739	269.759	1.148
84	93.855	74.260	1.264	262.644	158.259	1.660	198.525	125.246	1.585	586.421	499.693	1.174
85	372.931	209.742	1.778	245.759	169.479	1.450	132.835	87.315	1.521	321.295	266.993	1.203
86	244.574	106.826	2.289	205.884	140.081	1.470	128.248	91.647	1.399	363.268	187.398	1.938
87	281.096	176.453	1.593	320.100	226.825	1.411	161.649	97.448	1.659	322.058	216.640	1.487
88	359.034	298.860	1.201	202.211	122.069	1.657	116.570	58.530	1.992	404.859	268.380	1.509
89	326.281	152.989	2.133	173.387	121.412	1.428	101.673	67.674	1.502	234.135	134.491	1.741
90	228.845	103.083	2.220	208.933	150.913	1.384	143.303	102.917	1.392	337.589	200.442	1.684
91	165.163	139.788	1.182	134.740	83.595	1.612	111.384	75.989	1.466	343.650	220.922	1.556
92	223.317	104.078	2.146	231.311	160.473	1.441	136.784	90.844	1.506	334.696	242.710	1.379

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
93	275.240	190.217	1.447	253.475	124.044	2.043	249.573	74.239	3.362	530.680	415.923	1.276
94	212.628	149.102	1.426	161.035	124.232	1.296	91.876	60.413	1.521	371.713	295.148	1.259
95	324.972	144.432	2.250	211.369	100.000	2.114	112.657	49.132	2.293	317.745	276.597	1.149
96	164.880	109.080	1.512	213.199	126.285	1.688	196.805	64.114	3.070	526.684	390.882	1.347
97	204.277	109.910	1.859	339.413	255.830	1.327	158.974	67.742	2.347	367.796	301.979	1.218
98	384.757	232.726	1.653	194.849	112.227	1.736	98.777	56.801	1.739	343.280	255.566	1.343
99	304.334	310.872	0.979	215.705	114.289	1.887	123.077	69.289	1.776	380.575	325.905	1.168
100	303.524	158.231	1.918	211.081	152.142	1.387	106.687	71.907	1.484	261.118	207.662	1.257
101	203.779	181.939	1.120	172.076	101.958	1.688	117.551	80.646	1.458	262.476	211.302	1.242
102	332.746	259.053	1.284	172.076	101.958	1.688	117.551	80.646	1.458	335.857	255.462	1.315
103	188.122	114.043	1.650	211.369	100.000	2.114	119.882	79.894	1.501	335.857	255.462	1.315
104	299.043	236.317	1.265	191.203	130.701	1.463	112.657	49.132	2.293	394.979	298.440	1.323

Table G.2 Probable Maximum Precipitations (PMP) of different stations in the UBNB and the ratios of PMP to 10,000 years return period quantiles for 2-day

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
1	385.775	181.52394	2.1252005	356.744	240.00505	1.4864001	189.552	128.95238	1.4699344	297.112	242.55917	1.2249039
2	253.308	143.22304	1.7686244	235.792	149.32928	1.5790059	157.652	105.1703	1.4990206	297.215	270.03709	1.1006438
3	295.640	219.64932	1.3459624	332.490	226.89116	1.4654163	179.455	108.71999	1.6506164	298.819	204.41655	1.4618126
4	281.335	203.59398	1.3818451	255.136	115.85058	2.2022854	129.453	62.464246	2.0724292	458.264	351.8512	1.3024369
5	213.400	106.28595	2.0077916	255.292	176.03679	1.4502218	135.514	83.810494	1.6169096	262.680	243.14123	1.080358
6	318.298	199.72773	1.5936593	172.716	112.09627	1.5407784	124.379	75.95747	1.6374877	661.883	609.73577	1.0855249
7	257.073	122.87101	2.0922186	204.316	150.72711	1.3555378	113.287	82.495651	1.3732542	351.694	268.12951	1.3116575
9	265.451	170.10422	1.5605226	234.204	101.18726	2.3145613	172.784	108.37294	1.5943496	335.574	268.58279	1.249423
10	220.631	113.53946	1.9432115	200.527	139.29059	1.4396308	147.784	97.871927	1.5099763	285.107	238.97803	1.1930278
12	285.784	214.99933	1.3292316	293.948	198.16558	1.4833441	176.386	128.60311	1.3715553	340.448	296.16703	1.149513
13	249.693	122.36715	2.040524	293.257	202.42778	1.4487009	170.402	119.6639	1.4240018	358.136	307.57236	1.1643954

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
14	275.893	215.62295	1.2795182	297.971	192.74065	1.5459699	158.893	111.41734	1.4261094	359.795	249.8277	1.440173
15	256.048	166.02654	1.5422091	362.824	235.25713	1.5422461	168.571	65.849676	2.5599315	299.088	220.7459	1.354899
16	312.705	237.92142	1.3143203	245.434	163.19595	1.5039228	158.208	103.03784	1.5354338	249.780	188.10539	1.3278709
17	273.485	170.66158	1.6025005	221.546	138.06374	1.6046651	124.139	86.723352	1.4314418	466.235	421.95392	1.1049422
18	295.853	169.33883	1.7471077	255.847	116.25338	2.2007743	139.918	69.059276	2.0260579	348.082	306.32979	1.1362975
19	235.975	117.09176	2.0153011	293.257	202.42778	1.4487009	170.402	119.6639	1.4240018	369.151	200.60145	1.8402189
20	375.009	270.00324	1.3889067	255.136	115.85058	2.2022854	129.453	62.464246	2.0724292	484.397	385.74393	1.2557487
21	332.841	214.1041	1.5545768	255.136	115.85058	2.2022854	129.453	62.464246	2.0724292	484.397	385.74393	1.2557487
22	349.488	273.20696	1.2792054	364.841	235.25713	1.5508164	169.884	65.849676	2.5798771	287.020	171.17397	1.6767713
23	210.985	133.26577	1.5831914	188.581	124.26767	1.517542	129.506	87.792027	1.4751457	257.097	207.98951	1.2361051
24	246.137	153.3742	1.6048142	297.426	197.9865	1.502255	161.674	89.163274	1.8132318	356.559	259.73605	1.3727761
25	246.277	161.78002	1.5222971	224.857	166.01577	1.3544287	133.550	73.202417	1.8243974	343.761	220.91063	1.5561075
26	327.562	159.29549	2.0563188	209.886	126.46526	1.659637	130.826	88.562702	1.477209	347.498	208.39123	1.6675262
27	272.079	134.61993	2.0210874	255.847	116.25338	2.2007743	139.918	69.059276	2.0260579	375.571	332.00712	1.131214
28	200.999	123.14615	1.6322027	331.023	266.14141	1.2437854	162.824	91.174619	1.7858452	202.732	187.94717	1.0786661
29	284.977	160.99299	1.770121	332.490	226.89116	1.4654163	179.455	108.71999	1.6506164	298.819	204.41655	1.4618126
30	286.511	165.65217	1.7295964	323.193	207.26645	1.5593101	292.095	98.603635	2.9623116	533.812	481.41291	1.1088445
31	241.149	125.67586	1.9188181	254.532	146.57738	1.7365034	165.207	119.38991	1.3837587	469.587	466.22054	1.0072202
32	659.984	423.10249	1.5598675	284.799	202.24102	1.4082155	188.507	110.41447	1.7072687	339.661	295.23739	1.150466
33	215.933	115.0915	1.8761817	297.426	197.9865	1.502255	161.674	89.163274	1.8132318	356.559	259.73605	1.3727761
34	204.437	168.24461	1.2151171	178.638	107.95338	1.6547685	124.962	88.9402	1.4050165	445.056	320.30304	1.389483
35	191.382	116.83799	1.6380139	225.794	126.33521	1.78726	116.048	77.314543	1.5009804	486.737	454.24707	1.071525
36	220.020	94.980121	2.3164832	225.794	126.33521	1.78726	116.048	77.314543	1.5009804	464.285	363.75024	1.2763848
37	248.753	124.97676	1.9903941	284.799	202.24102	1.4082155	188.507	110.41447	1.7072687	504.100	495.25318	1.017864
38	225.236	157.23373	1.4324896	236.778	157.25095	1.5057306	167.846	108.26737	1.5502933	476.870	486.40681	0.9803929
39	256.928	134.44533	1.9110196	335.021	220.2865	1.5208439	182.261	123.80951	1.4721067	303.969	250.78277	1.2120812
40	253.510	126.71565	2.0006203	297.426	197.9865	1.502255	161.674	89.163274	1.8132318	359.795	249.8277	1.440173
41	280.563	190.00516	1.4766088	235.792	149.32928	1.5790059	157.652	105.1703	1.4990206	321.529	271.00164	1.1864485
42	359.463	173.00009	2.077821	231.173	122.24768	1.8910186	139.906	91.571011	1.5278445	436.884	368.81255	1.1845681
43	253.406	180.09655	1.4070571	225.794	126.33521	1.78726	116.048	77.314543	1.5009804	496.279	399.90514	1.2409914
44	463.049	321.64644	1.4396204	349.740	251.08421	1.3929205	198.366	138.87835	1.4283426	396.340	301.89205	1.3128524
45	363.596	222.239	1.6360574	204.588	139.44007	1.4672088	145.147	96.266375	1.5077591	411.413	384.1881	1.0708626
46	243.645	106.88669	2.279474	188.581	124.26767	1.517542	129.506	87.792027	1.4751457	249.780	188.10539	1.3278709

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
47	252.431	164.42631	1.535224	349.740	251.08421	1.3929205	198.366	138.87835	1.4283426	396.340	301.89205	1.3128524
48	300.336	220.86877	1.3597934	212.282	133.09919	1.5949174	151.588	93.639082	1.6188516	355.975	304.54322	1.1688811
49	307.113	237.16651	1.2949239	236.778	157.25095	1.5057306	167.846	108.26737	1.5502933	476.870	486.40681	0.9803929
51	268.166	144.66649	1.8536857	208.860	111.43681	1.8742492	150.011	95.88848	1.5644307	351.700	270.18794	1.3016848
52	217.067	114.15688	1.9014805	235.792	149.32928	1.5790059	157.652	105.1703	1.4990206	297.215	270.03709	1.1006438
53	196.210	103.30623	1.8993054	223.776	138.06374	1.6208152	125.563	86.723352	1.4478513	464.713	425.31063	1.0926429
54	228.459	174.10883	1.3121637	331.023	266.14141	1.2437854	162.824	91.174619	1.7858452	202.732	187.94717	1.0786661
56	241.289	138.64437	1.7403463	255.292	176.03679	1.4502218	135.514	83.810494	1.6169096	262.680	243.14123	1.080358
57	298.936	137.48485	2.1743177	220.393	154.88034	1.4229898	141.076	92.688827	1.5220362	345.020	210.05752	1.6425001
58	365.687	261.47016	1.3985816	356.744	240.00505	1.4864001	189.552	128.95238	1.4699344	330.440	222.66569	1.4840193
59	254.428	148.58121	1.71238	235.792	149.32928	1.5790059	157.652	105.1703	1.4990206	297.215	270.03709	1.1006438
60	233.570	131.34497	1.7782972	234.204	101.18726	2.3145613	172.784	108.37294	1.5943496	396.852	381.04013	1.0414964
62	222.955	149.01123	1.4962284	234.204	101.18726	2.3145613	172.784	108.37294	1.5943496	406.299	364.82985	1.1136677
63	268.935	129.06795	2.0836712	213.413	153.64437	1.3890043	117.991	80.214817	1.4709379	451.129	427.21279	1.055981
65	486.772	306.42412	1.5885563	224.954	129.65768	1.7349876	128.658	76.836049	1.6744421	484.397	385.74393	1.2557487
66	157.346	81.058573	1.9411399	201.718	145.5404	1.3859958	168.835	107.45945	1.5711535	268.552	264.31763	1.0160186
67	242.548	150.48752	1.6117498	188.581	124.26767	1.517542	129.506	87.792027	1.4751457	322.054	227.73862	1.4141381
68	356.635	179.62028	1.9854933	201.718	145.5404	1.3859958	168.835	107.45945	1.5711535	285.107	238.97803	1.1930278
69	327.196	174.11532	1.8791942	323.193	207.26645	1.5593101	292.095	98.603635	2.9623116	533.812	481.41291	1.1088445
70	344.256	244.39974	1.4085758	245.434	163.19595	1.5039228	158.208	103.03784	1.5354338	389.552	272.66015	1.4287101
71	273.858	139.28642	1.9661493	345.702	181.29605	1.9068387	124.379	75.95747	1.6374877	369.892	256.1632	1.4439691
72	274.773	167.17054	1.6436713	188.581	124.26767	1.517542	129.506	87.792027	1.4751457	277.518	204.49845	1.357067
73	224.142	112.16649	1.9982992	188.581	124.26767	1.517542	129.506	87.792027	1.4751457	277.518	204.49845	1.357067
74	212.836	125.36241	1.6977667	240.460	151.74588	1.5846255	209.225	90.728618	2.3060527	601.386	541.96629	1.1096364
77	366.201	299.25144	1.223724	254.532	146.57738	1.7365034	165.207	119.38991	1.3837587	436.884	368.81255	1.1845681
78	184.982	100.98566	1.8317625	197.803	132.21267	1.4960968	117.404	78.566767	1.4943262	584.088	550.6528	1.0607187
79	252.340	133.79633	1.8860022	255.136	115.85058	2.2022854	129.453	62.464246	2.0724292	458.264	351.8512	1.3024369
80	288.359	196.76694	1.4654875	245.109	155.1904	1.5794083	150.034	102.06022	1.4700568	324.937	289.13672	1.1238163
81	256.334	176.27	1.4542115	213.413	153.64437	1.3890043	117.991	80.214817	1.4709379	408.784	390.51225	1.0467884
82	278.197	194.68811	1.4289361	423.087	226.60482	1.8670681	194.221	114.36565	1.6982455	443.500	380.07607	1.1668723
83	276.337	165.55414	1.6691657	297.971	192.74065	1.5459699	158.893	111.41734	1.4261094	326.703	270.04174	1.2098248
85	357.452	267.93359	1.3341053	297.971	192.74065	1.5459699	158.893	111.41734	1.4261094	335.676	302.15495	1.1109412
86	394.180	165.68605	2.3790767	258.764	132.78573	1.9487334	169.307	86.06892	1.9671145	384.500	245.93991	1.5633905

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
87	284.734	206.93959	1.3759264	356.744	240.00505	1.4864001	189.552	128.95238	1.4699344	317.244	237.60723	1.3351617
88	436.233	185.9943	2.3454099	245.109	155.1904	1.5794083	150.034	102.06022	1.4700568	438.468	335.0253	1.308761
89	236.566	139.06281	1.701142	188.581	124.26767	1.517542	129.506	87.792027	1.4751457	306.779	249.41837	1.2299777
90	245.164	179.00208	1.3696181	273.282	196.83001	1.3884162	174.731	99.120115	1.7628215	365.234	245.46574	1.4879208
91	145.829	72.274781	2.0177049	169.607	123.50823	1.373247	165.469	94.19714	1.7566289	371.186	234.71	1.5814672
92	249.997	128.99359	1.9380565	293.257	202.42778	1.4487009	170.402	119.6639	1.4240018	355.550	227.79809	1.5608135
94	240.288	154.45786	1.5556852	223.776	138.06374	1.6208152	125.563	86.723352	1.4478513	464.713	425.31063	1.0926429
95	302.108	172.20091	1.7543936	255.136	115.85058	2.2022854	129.453	62.464246	2.0724292	433.216	329.4298	1.3150472
96	245.577	126.96687	1.9341796	299.432	189.74137	1.5781079	224.832	78.389886	2.8681301	561.320	476.17581	1.1788088
97	270.227	102.59645	2.6338779	423.087	226.60482	1.8670681	194.221	114.36565	1.6982455	444.673	407.21242	1.0919931
98	332.841	214.1041	1.5545768	224.954	129.65768	1.7349876	128.658	76.836049	1.6744421	421.227	337.13478	1.2494309
99	288.265	108.64464	2.6532849	254.532	146.57738	1.7365034	165.207	119.38991	1.3837587	436.884	368.81255	1.1845681
100	268.215	123.03001	2.1800781	255.292	176.03679	1.4502218	135.514	83.810494	1.6169096	297.183	273.95916	1.0847711
102	346.821	213.66217	1.6232236	236.778	157.25095	1.5057306	167.846	108.26737	1.5502933	441.888	404.20868	1.0932174
103	221.532	161.5181	1.3715617	235.792	149.32928	1.5790059	157.652	105.1703	1.4990206	441.888	404.20868	1.0932174
104	269.320	175.71298	1.5327275	255.136	115.85058	2.2022854	129.453	62.464246	2.0724292	484.397	385.74393	1.2557487

Table G.3 Probable Maximum Precipitations (PMP) of different stations in the UBNB and the ratios of PMP to 10,000 years return period quantiles for 3-day

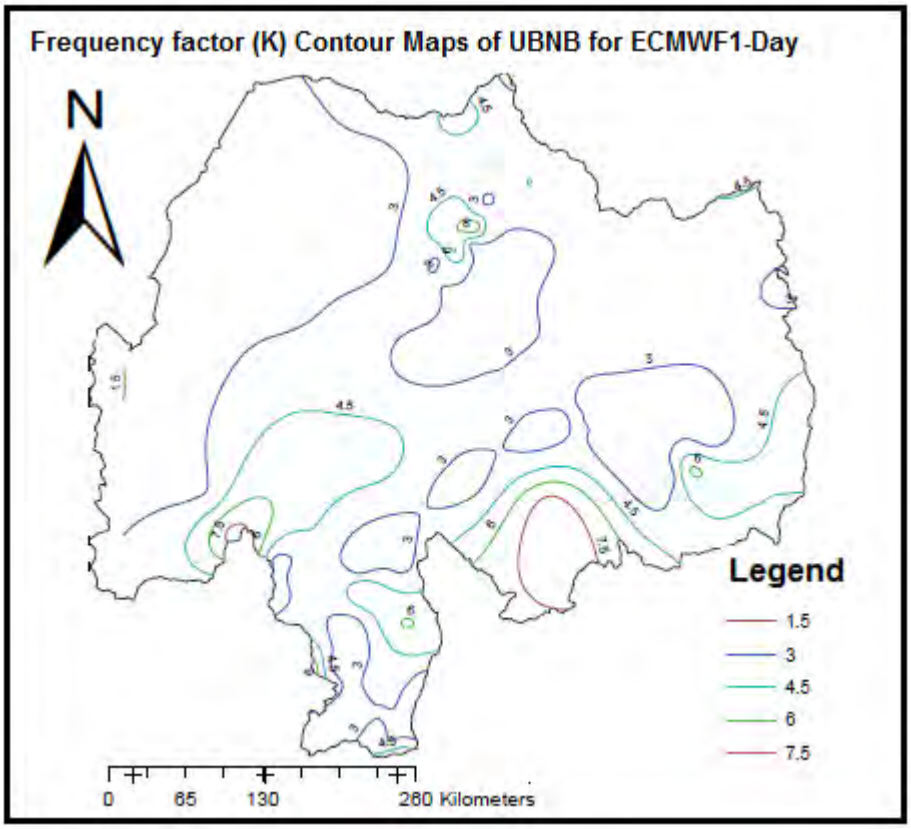
In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
1	476.430	277.11283	1.7192643	335.055	226.57881	1.4787558	209.455	108.76164	1.9258133	292.920	266.86516	1.0976315
2	320.043	149.54229	2.1401479	277.466	191.86465	1.4461557	215.098	126.72192	1.6973981	359.216	263.75862	1.361912
3	420.475	227.67339	1.8468344	314.852	229.6234	1.3711674	185.643	97.73782	1.8993969	285.256	285.20262	1.0001879
4	348.290	259.26137	1.3433923	278.287	135.39767	2.05533	169.772	81.405953	2.0854977	456.543	323.18467	1.412637
5	329.803	166.84232	1.9767367	268.814	205.73051	1.3066312	169.935	115.46507	1.4717434	325.611	203.20046	1.6024105
6	411.822	238.0687	1.7298442	208.511	155.80103	1.3383178	161.846	80.297941	2.0155658	713.064	658.47647	1.0828995
7	309.347	196.67595	1.5728743	237.028	178.2218	1.3299613	156.182	88.894923	1.7569312	386.373	277.50773	1.392296
9	328.071	216.70961	1.5138731	253.569	116.12499	2.1835838	203.086	104.03886	1.9520196	383.426	327.31331	1.1714342
10	271.243	179.15046	1.5140523	226.628	118.7711	1.9081073	169.194	103.10928	1.6409174	321.290	237.49265	1.352842
12	521.070	151.39433	3.4418036	286.178	222.12823	1.2883481	200.278	111.24478	1.8003317	388.411	366.59655	1.0595055
13	318.942	186.33496	1.7116603	285.986	202.59576	1.4116081	204.595	124.99928	1.6367731	408.909	351.31339	1.1639438
14	361.625	196.11492	1.843942	275.218	175.07433	1.5720088	185.939	111.19414	1.6722002	380.249	369.3583	1.029486
15	262.011	188.23352	1.3919477	370.992	257.72657	1.439479	196.969	83.415519	2.3612978	320.300	301.93139	1.0608382
16	413.013	253.19187	1.6312252	249.665	172.82729	1.4445945	176.749	109.2006	1.6185762	289.723	156.14645	1.8554554
17	333.466	239.27867	1.3936311	248.396	179.60409	1.3830221	172.215	118.41858	1.4542891	466.693	402.19629	1.1603612
18	414.159	192.20984	2.1547233	289.781	139.33162	2.079795	184.865	97.441236	1.8971994	432.254	373.86933	1.156164
19	313.817	128.819	2.4361093	285.986	202.59576	1.4116081	204.595	124.99928	1.6367731	391.232	284.46162	1.3753419
20	449.397	254.34166	1.7669025	278.287	135.39767	2.05533	169.772	81.405953	2.0854977	494.634	401.51284	1.2319264
21	434.548	260.85311	1.6658715	278.287	135.39767	2.05533	169.772	81.405953	2.0854977	494.634	401.51284	1.2319264
22	529.819	225.78883	2.3465235	373.172	257.72657	1.4479357	198.468	83.415519	2.379275	298.969	312.21306	0.9575801
23	260.113	125.91495	2.0657837	227.458	157.71166	1.4422387	166.432	107.80011	1.5438965	296.067	175.33055	1.6886218
24	281.859	200.10185	1.4085774	283.876	192.75471	1.4727321	176.867	100.80739	1.7545048	382.622	349.40792	1.0950568
25	310.909	152.07069	2.0445029	303.259	216.54546	1.4004419	178.428	84.33901	2.1156076	351.932	236.43983	1.488464
26	370.163	197.59528	1.8733401	275.989	129.4592	2.1318609	204.340	122.97015	1.6617074	346.924	220.45091	1.5737023
27	342.098	167.02396	2.0481983	289.781	139.33162	2.079795	184.865	97.441236	1.8971994	453.808	422.82765	1.0732698
28	257.936	152.54629	1.690869	336.526	262.81715	1.2804566	192.131	94.301333	2.0374168	260.932	188.87274	1.3815254
29	345.155	176.07702	1.9602515	314.852	229.6234	1.3711674	185.643	97.73782	1.8993969	285.256	285.20262	1.0001879
30	329.637	152.11807	2.1669794	355.943	205.23866	1.7342902	319.257	99.881789	3.1963476	647.299	467.32723	1.3851088
31	311.412	157.0136	1.9833445	258.177	129.23004	1.9978065	178.801	87.103514	2.0527423	417.252	376.80135	1.1073536
32	874.468	529.0361	1.6529464	270.842	203.54562	1.330622	207.091	113.43778	1.82559	379.705	332.20071	1.142998
33	303.219	198.69095	1.5260824	283.876	192.75471	1.4727321	176.867	100.80739	1.7545048	382.622	349.40792	1.0950568

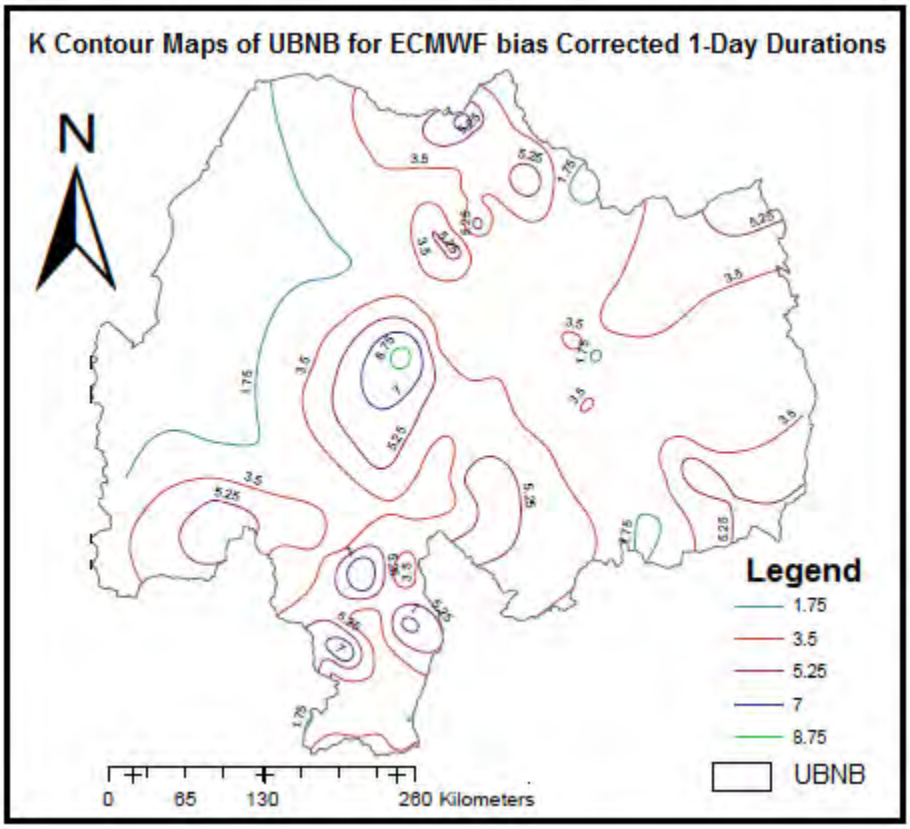
In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
34	254.416	176.98267	1.4375209	237.857	138.74259	1.714373	178.302	82.802466	2.1533464	527.827	361.93249	1.4583573
35	241.990	147.99219	1.6351556	280.985	157.29963	1.7863051	156.621	82.837992	1.8906935	518.776	369.25768	1.404915
36	236.357	114.24726	2.0688182	280.985	157.29963	1.7863051	156.621	82.837992	1.8906935	472.239	318.67732	1.4818722
37	295.332	135.30973	2.1826405	270.842	203.54562	1.330622	207.091	113.43778	1.82559	557.181	544.06539	1.0241075
38	314.880	241.43737	1.3041911	276.847	188.34659	1.4698811	201.637	135.25548	1.490785	459.872	422.07041	1.0895625
39	305.919	135.98759	2.2496071	326.670	237.08779	1.3778423	204.160	99.823361	2.0452141	302.167	275.55083	1.0965934
40	345.646	174.53302	1.9804026	283.876	192.75471	1.4727321	176.867	100.80739	1.7545048	380.249	369.3583	1.029486
41	368.372	259.47543	1.4196783	277.466	191.86465	1.4461557	215.098	126.72192	1.6973981	316.373	271.33644	1.1659823
42	407.801	207.50215	1.9652837	249.464	137.67427	1.8119862	172.299	107.38556	1.6044864	428.553	360.93707	1.1873334
43	317.730	210.30894	1.510777	280.985	157.29963	1.7863051	156.621	82.837992	1.8906935	490.209	322.72183	1.5189846
44	560.041	366.90511	1.5263911	326.286	239.33289	1.3633137	218.115	118.61836	1.838796	436.929	414.92459	1.053033
45	544.504	343.52267	1.585059	245.593	180.47327	1.3608255	190.286	116.97987	1.6266536	487.674	437.25554	1.1153075
46	336.244	156.50063	2.1485143	227.458	157.71166	1.4422387	166.432	107.80011	1.5438965	289.723	156.14645	1.8554554
47	307.903	174.57583	1.7637231	326.286	239.33289	1.3633137	218.115	118.61836	1.838796	436.929	414.92459	1.053033
48	384.573	270.11375	1.4237455	263.780	143.25468	1.8413335	195.984	105.83494	1.8517849	335.253	231.29683	1.4494475
49	358.089	281.55844	1.2718103	276.847	188.34659	1.4698811	201.637	135.25548	1.490785	459.872	422.07041	1.0895625
51	347.420	178.69201	1.9442377	273.445	163.73743	1.6700186	204.142	125.55727	1.6258849	366.679	273.1609	1.3423568
52	281.844	145.09986	1.9424155	277.466	191.86465	1.4461557	215.098	126.72192	1.6973981	359.216	263.75862	1.361912
53	230.952	183.56439	1.258155	250.978	179.60409	1.3973985	173.996	118.41858	1.4693297	469.155	345.80765	1.3566921
54	314.002	222.33277	1.412305	336.526	262.81715	1.2804566	192.131	94.301333	2.0374168	260.932	188.87274	1.3815254
56	289.643	181.20026	1.5984696	268.814	205.73051	1.3066312	169.935	115.46507	1.4717434	325.611	203.20046	1.6024105
57	376.404	157.6595	2.3874502	226.251	140.04982	1.6155068	149.111	92.346971	1.6146774	387.947	302.46778	1.2826077
58	481.601	348.47517	1.3820233	335.055	226.57881	1.4787558	209.455	108.76164	1.9258133	369.064	292.96251	1.259766
59	332.623	240.46328	1.383259	277.466	191.86465	1.4461557	215.098	126.72192	1.6973981	359.216	263.75862	1.361912
60	281.689	155.86302	1.8072882	253.569	116.12499	2.1835838	203.086	104.03886	1.9520196	488.626	437.90732	1.1158205
62	267.327	143.66764	1.8607292	253.569	116.12499	2.1835838	203.086	104.03886	1.9520196	507.309	464.64636	1.0918176
63	394.551	213.71895	1.8461225	263.426	175.29409	1.5027633	162.986	82.442726	1.976961	444.509	366.2805	1.2135764
65	528.346	345.64835	1.528564	218.131	124.61969	1.7503771	144.830	93.319971	1.5519702	494.634	401.51284	1.2319264
66	237.055	131.36405	1.8045646	230.993	161.88626	1.4268835	190.265	116.22884	1.6369852	329.226	256.45276	1.2837693
67	313.601	186.41472	1.6822736	227.458	157.71166	1.4422387	166.432	107.80011	1.5438965	317.858	222.05321	1.431451
68	337.969	147.30197	2.2943974	230.993	161.88626	1.4268835	190.265	116.22884	1.6369852	321.290	237.49265	1.352842

In situ Data				ECMWF			ECMWF With bias Correction			GLADS		
Station No.	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000	PMP(mm)	Rainfall Quantiles (mm) for T=10,0000	PMP/ Rainfall Quantiles for T=10,0000
69	429.805	212.99007	2.0179601	355.943	205.23866	1.7342902	319.257	99.881789	3.1963476	647.299	467.32723	1.3851088
70	442.666	305.47643	1.4491008	249.665	172.82729	1.4445945	176.749	109.2006	1.6185762	432.702	356.15915	1.2149131
71	390.363	170.96991	2.2832284	208.511	155.80103	1.3383178	161.846	80.297941	2.0155658	380.725	278.86135	1.3652847
72	357.653	204.3591	1.7501204	227.458	157.71166	1.4422387	166.432	107.80011	1.5438965	327.911	247.4588	1.3251115
73	320.110	148.54072	2.1550292	227.458	157.71166	1.4422387	166.432	107.80011	1.5438965	327.911	247.4588	1.3251115
74	277.137	143.20882	1.9351944	268.100	173.57815	1.54455	268.546	128.45456	2.0905901	658.561	588.72442	1.1186239
77	471.021	309.55187	1.5216225	254.807	129.23004	1.9717327	178.801	87.103514	2.0527423	428.553	360.93707	1.1873334
78	215.410	102.90741	2.0932382	260.463	190.90548	1.364356	154.295	104.48098	1.4767766	607.311	547.01165	1.1102345
79	278.953	161.82203	1.7238232	278.287	135.39767	2.05533	169.772	81.405953	2.0854977	456.543	323.18467	1.412637
80	367.153	264.00424	1.3907098	283.516	151.56553	1.8705816	204.028	102.40962	1.9922786	375.795	322.87516	1.1639023
81	353.414	237.33475	1.4890963	263.426	175.29409	1.5027633	162.986	82.442726	1.976961	382.701	327.55861	1.1683425
82	345.610	174.53939	1.980125	408.025	282.97281	1.441924	218.028	138.87002	1.5700162	488.881	441.83553	1.1064768
83	338.982	221.50982	1.5303248	275.218	175.07433	1.5720088	185.939	111.19414	1.6722002	350.202	312.81147	1.1195305
85	442.164	285.64164	1.547966	275.218	175.07433	1.5720088	185.939	111.19414	1.6722002	361.361	324.89894	1.1122269
86	557.824	249.20614	2.2384027	275.712	140.34266	1.9645634	182.092	99.220046	1.8352368	418.382	259.85293	1.6100711
87	315.777	222.64421	1.418302	335.055	226.57881	1.4787558	209.455	108.76164	1.9258133	333.363	248.77786	1.3400014
88	522.533	280.33325	1.86397	283.516	151.56553	1.8705816	204.028	102.40962	1.9922786	413.608	357.95288	1.1554817
89	339.338	199.21143	1.7034039	227.458	157.71166	1.4422387	166.432	107.80011	1.5438965	312.427	198.64794	1.5727673
90	329.489	217.41072	1.5155157	286.387	182.3287	1.5707173	203.750	99.760042	2.0424057	387.308	247.22628	1.5666134
91	245.364	84.889144	2.8904031	209.685	154.41321	1.3579485	198.321	97.581259	2.0323668	467.860	326.01052	1.4351064
92	305.099	154.14005	1.9793592	285.986	202.59576	1.4116081	204.595	124.99928	1.6367731	380.240	325.62193	1.1677357
94	285.444	160.12206	1.7826634	250.978	179.60409	1.3973985	173.996	118.41858	1.4693297	469.155	345.80765	1.3566921
95	384.020	228.94889	1.677319	278.287	135.39767	2.05533	169.772	81.405953	2.0854977	467.335	359.74106	1.2990867
96	306.408	124.39435	2.4632009	389.045	202.53746	1.9208553	265.723	93.02425	2.8564907	670.470	590.93025	1.1346015
97	362.000	134.72911	2.6868713	408.025	282.97281	1.441924	218.028	138.87002	1.5700162	487.482	414.65319	1.1756375
98	440.114	260.85311	1.6872097	218.131	124.61969	1.7503771	156.621	82.837992	1.8906935	431.476	357.11984	1.2082095
99	349.855	133.34941	2.6235973	254.807	129.23004	1.9717327	178.801	87.103514	2.0527423	428.553	360.93707	1.1873334
100	338.855	143.99273	2.3532755	268.814	129.23004	2.0801194	169.935	115.46507	1.4717434	346.117	288.13757	1.2012217
102	419.432	248.95771	1.6847513	276.847	188.34659	1.4698811	201.637	135.25548	1.490785	431.324	443.34553	0.9728856
103	298.781	228.1933	1.3093338	277.466	191.86465	1.4461557	215.098	126.72192	1.6973981	431.324	443.34553	0.9728856
104	347.817	162.74533	2.1371856	278.287	135.39767	2.05533	169.772	81.405953	2.0854977	494.634	401.51284	1.2319264

APPENDIX H: K and PMP contour Maps of UBNB

Figure H1. Frequency factor (K) Contour Maps of UBNB for both in-situ and reanalysis products using Hershfield's frequency equation




K Contour Maps of UBNB for ECMWF bias Corrected 1-Day Durations
N
Legend
1.75
3.5
5.25
7
8.75
UBNB
0
65
130
260 Kilometers

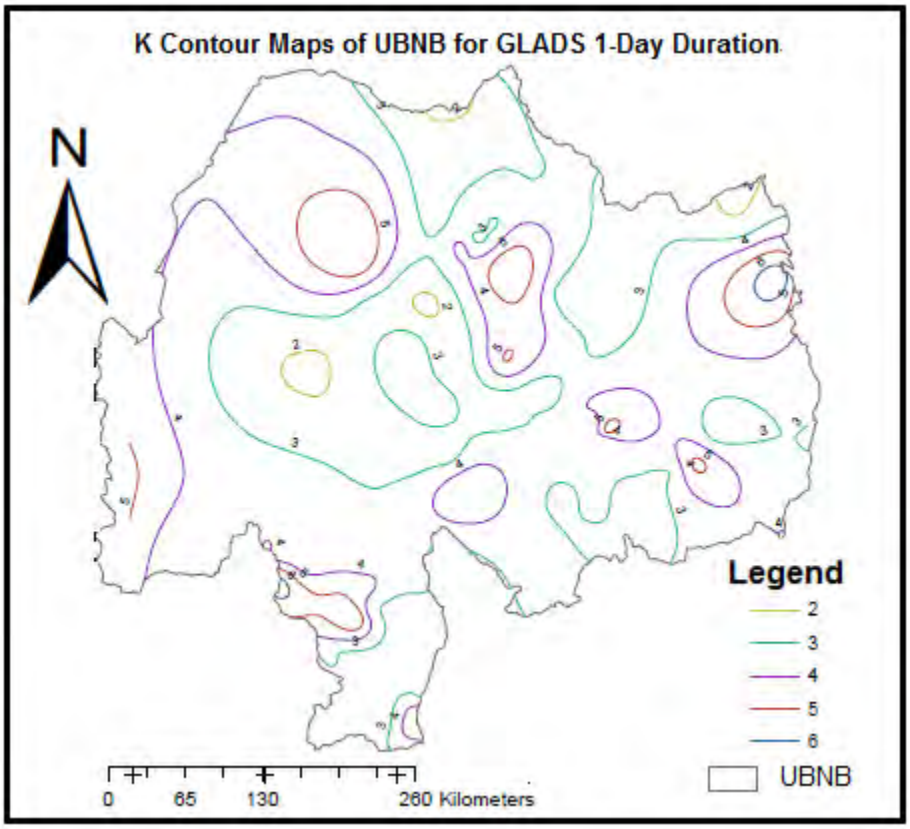
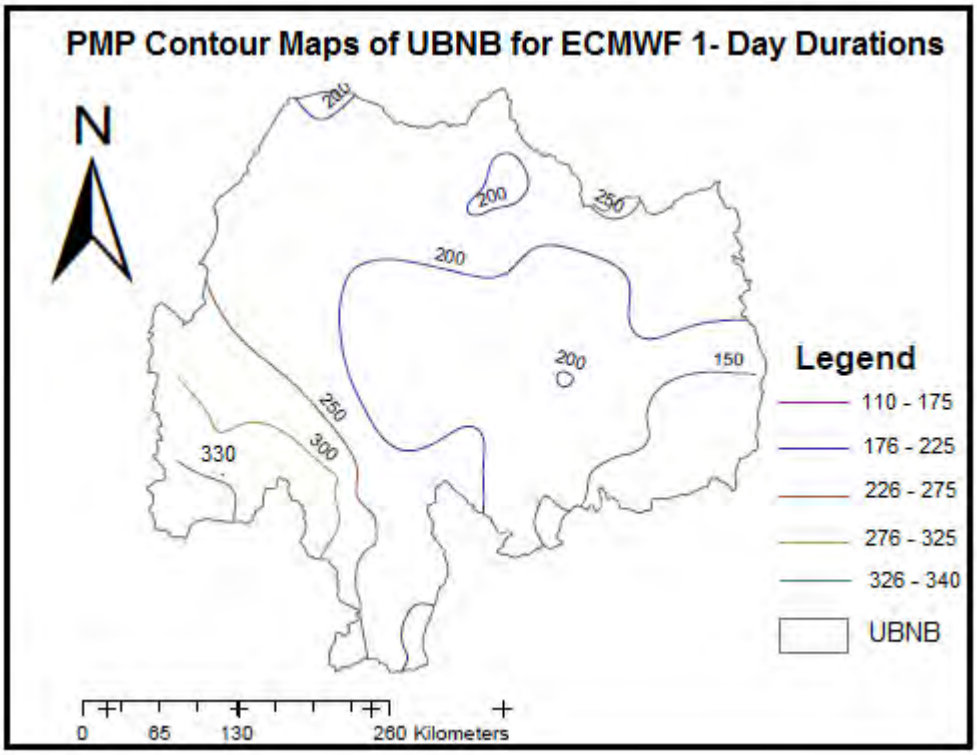
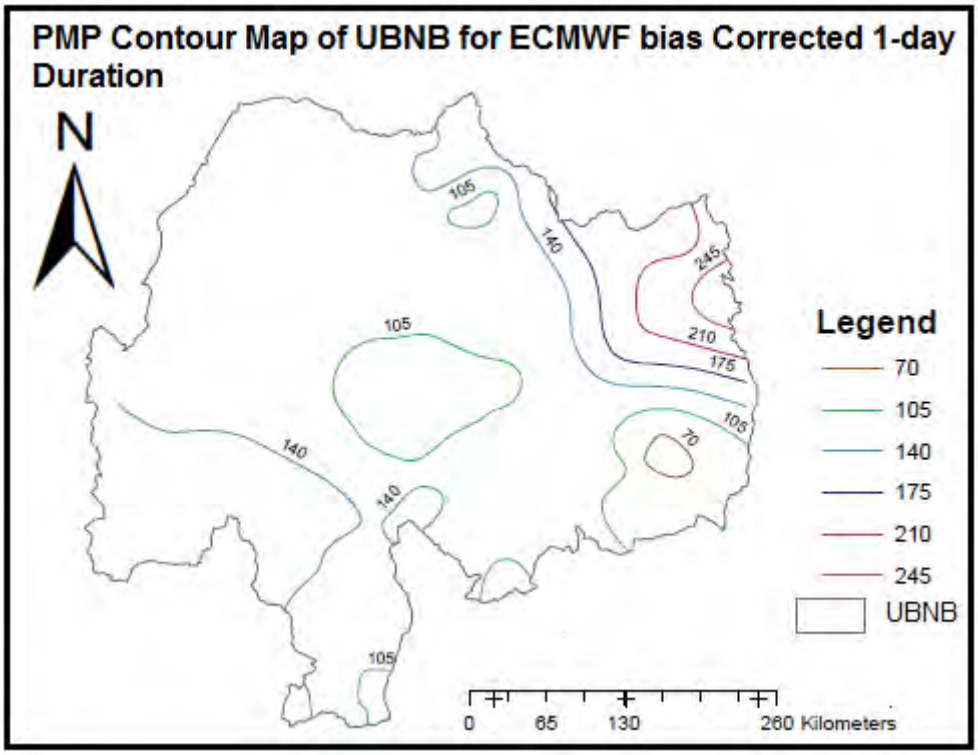
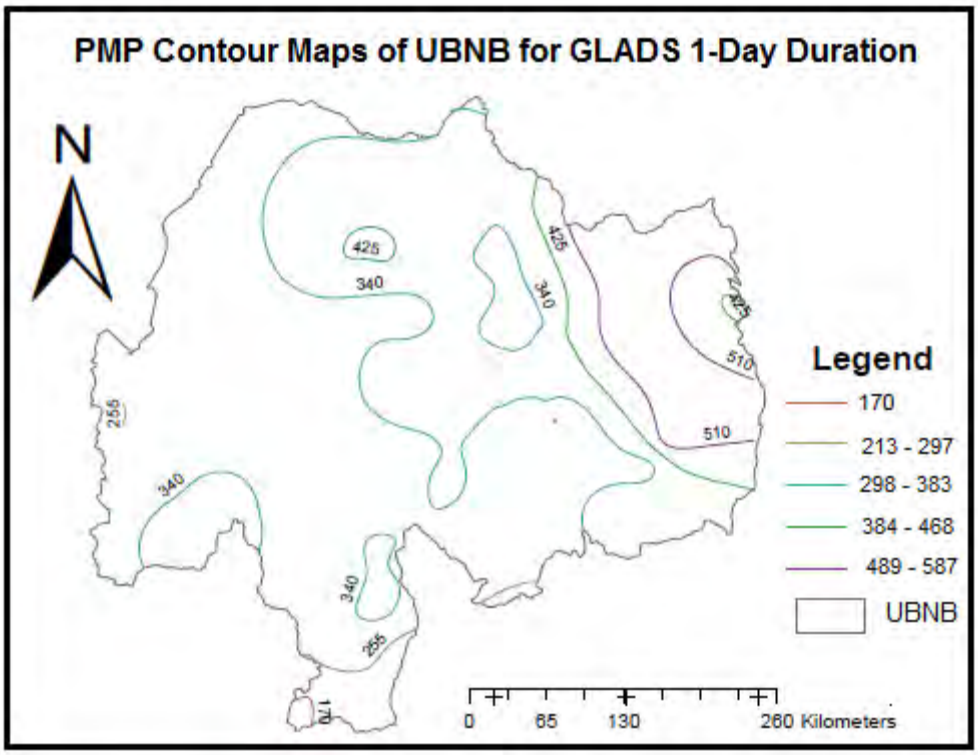
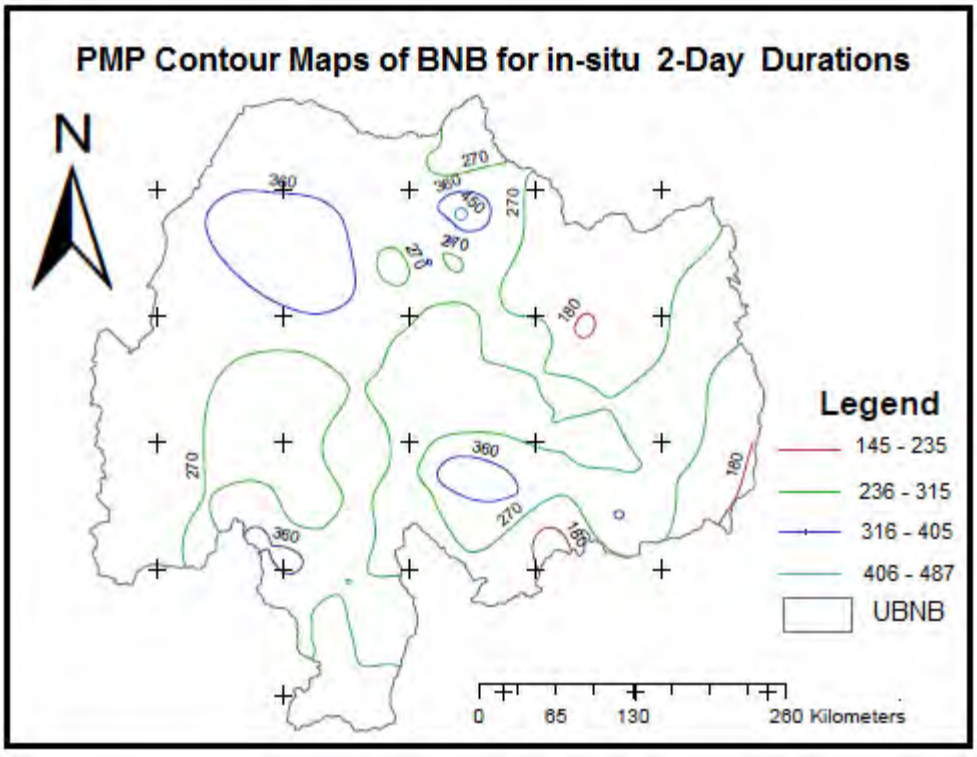

K Contour Maps of UBNB for GLADS 1-Day Duration
N
Legend
2
3
4
5
6
UBNB
0
65
130
260 Kilometers

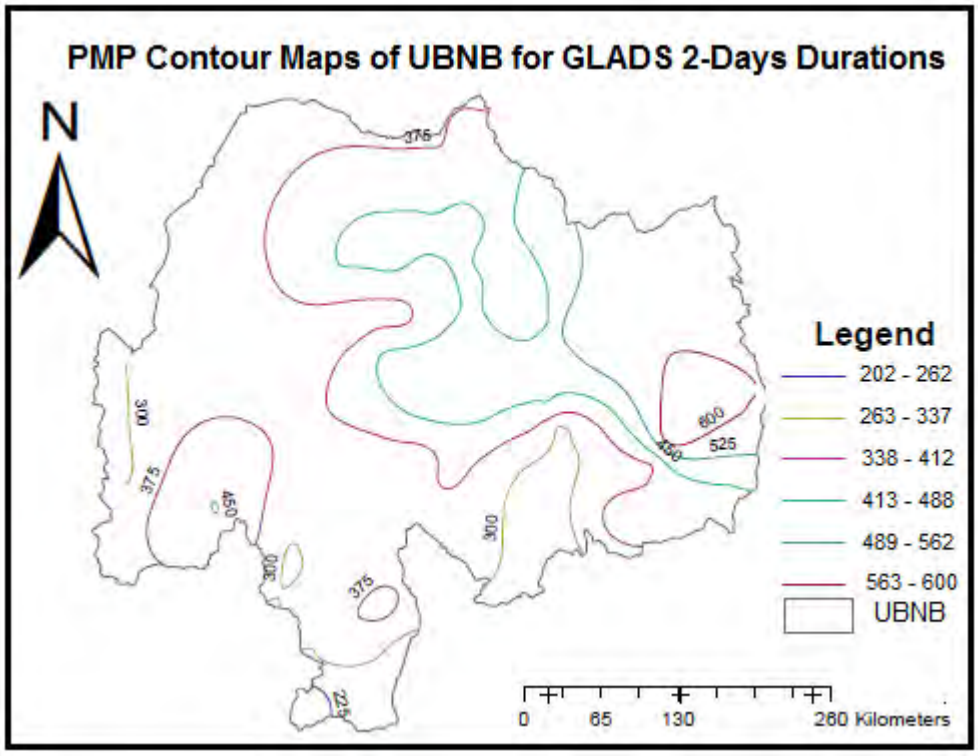
Figure H2. PMP (mm) Contour Maps of UBNB for both in-situ and reanalysis products using Hershfield's frequency equation

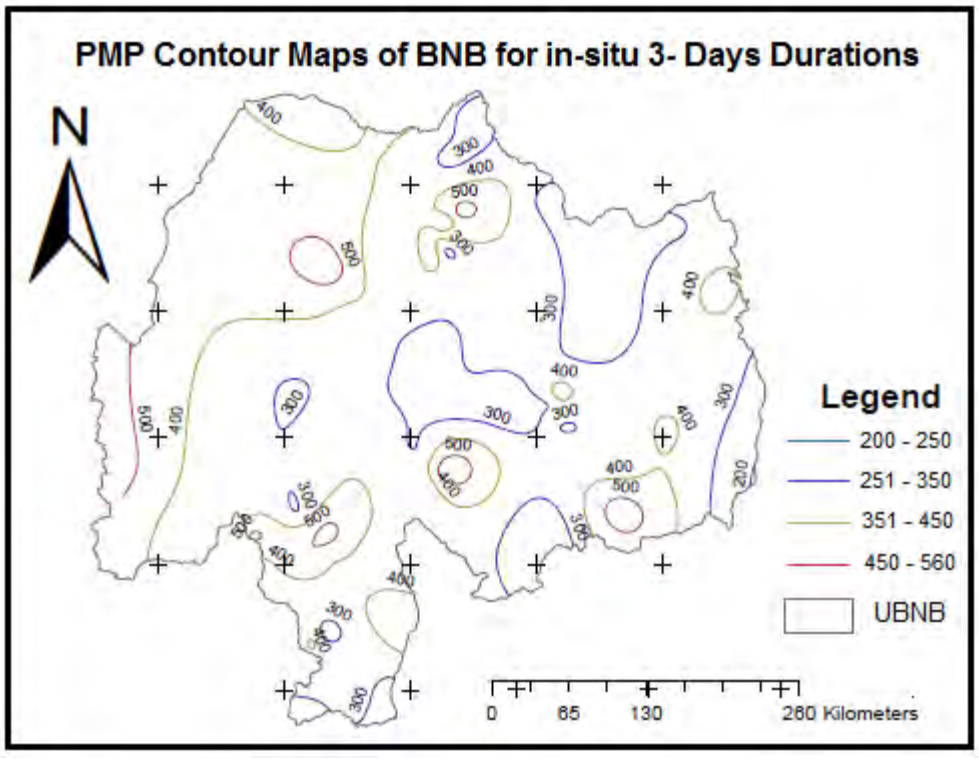





PMP Contour Maps of UBNB for GLADS 1-Day Duration
N
425
340
425
340
425
510
510
255
340
340
255
170
Legend
170
213 - 297
298 - 383
384 - 468
489 - 587
UBNB
0
65
130
260 Kilometers


PMP Contour Maps of BNB for in-situ 2-Day Durations
N
360
360
270
360
270
270
270
180
270
360
270
360
180
180
Legend
145 - 235
236 - 315
316 - 405
406 - 487
UBNB
0
65
130
260 Kilometers


PMP Contour Maps of UBNB for GLADS 2-Days Durations
N
Legend
202 - 262
263 - 337
338 - 412
413 - 488
489 - 562
563 - 600
UBNB
0
65
130
260 Kilometers


PMP Contour Maps of BNB for in-situ 3- Days Durations
N
Legend
200 - 250
251 - 350
351 - 450
450 - 560
UBNB
0
65
130
260 Kilometers

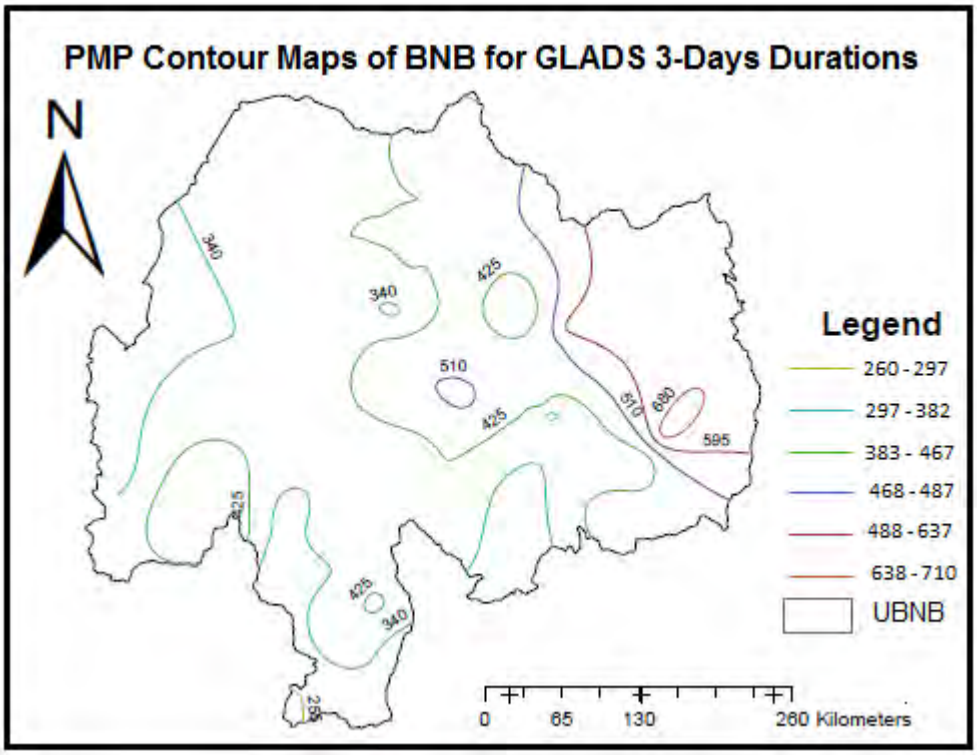
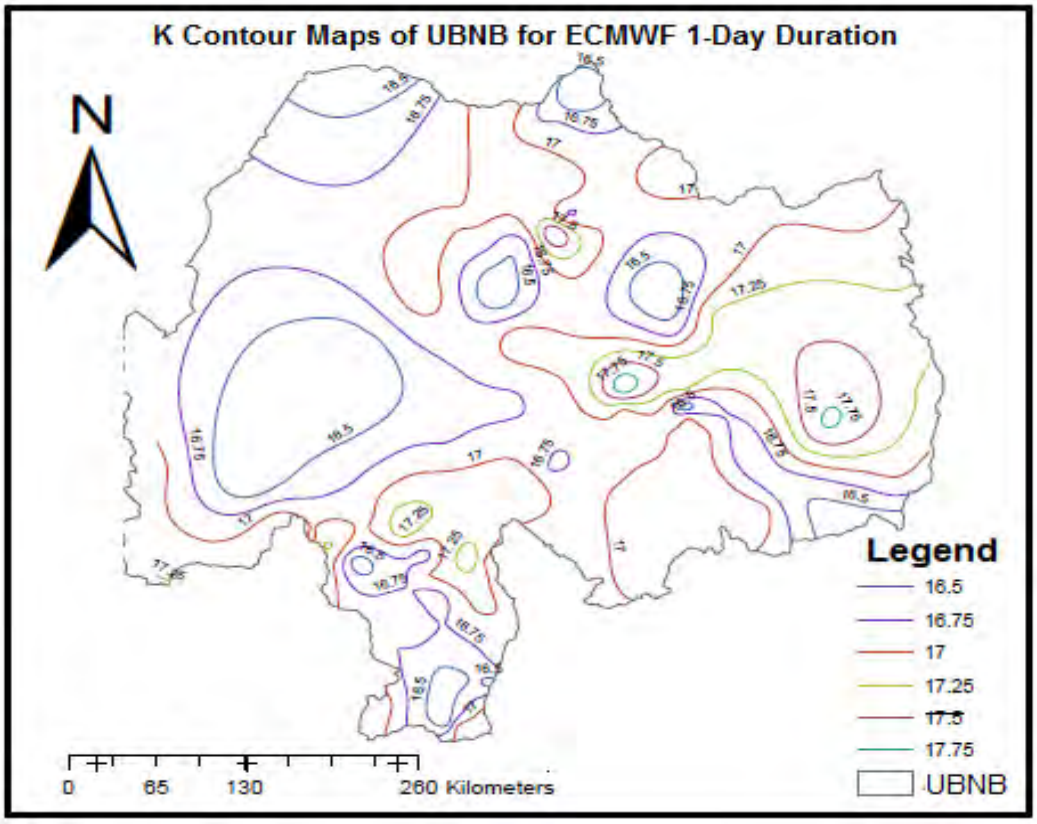
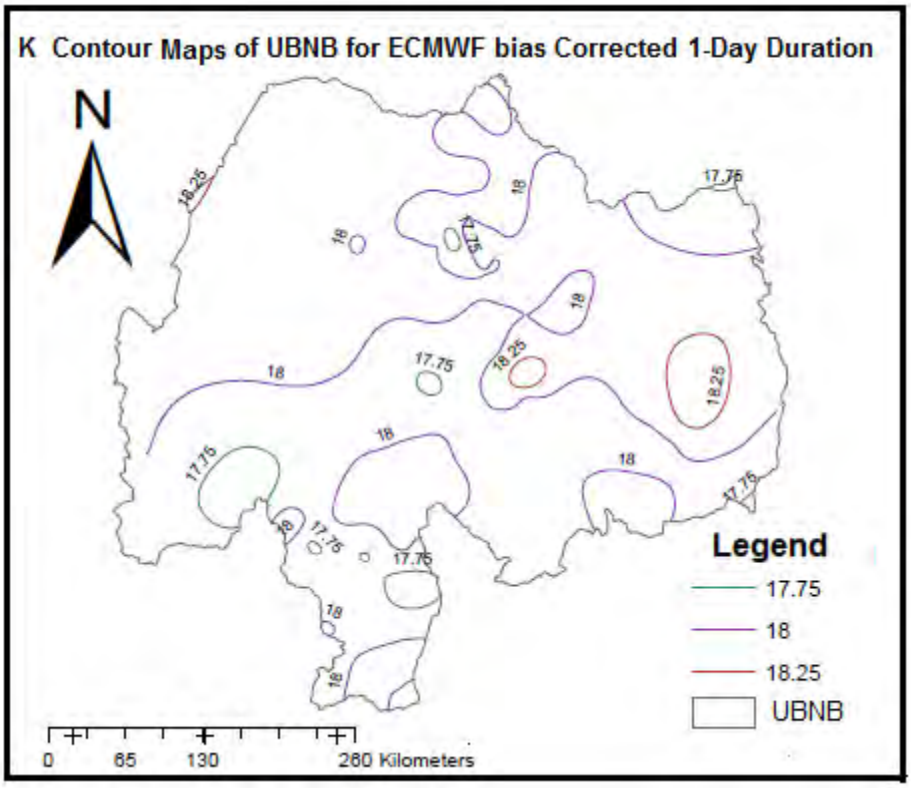


Figure H3. Frequency factor (K) Contour Maps of UBNB both in-situ and reanalysis products using Hershfield's Chart.




K Contour Maps of UBNB for ECMWF bias Corrected 1-Day Duration
N
Legend
17.75
18
18.25
UBNB
0
65
130
260 Kilometers

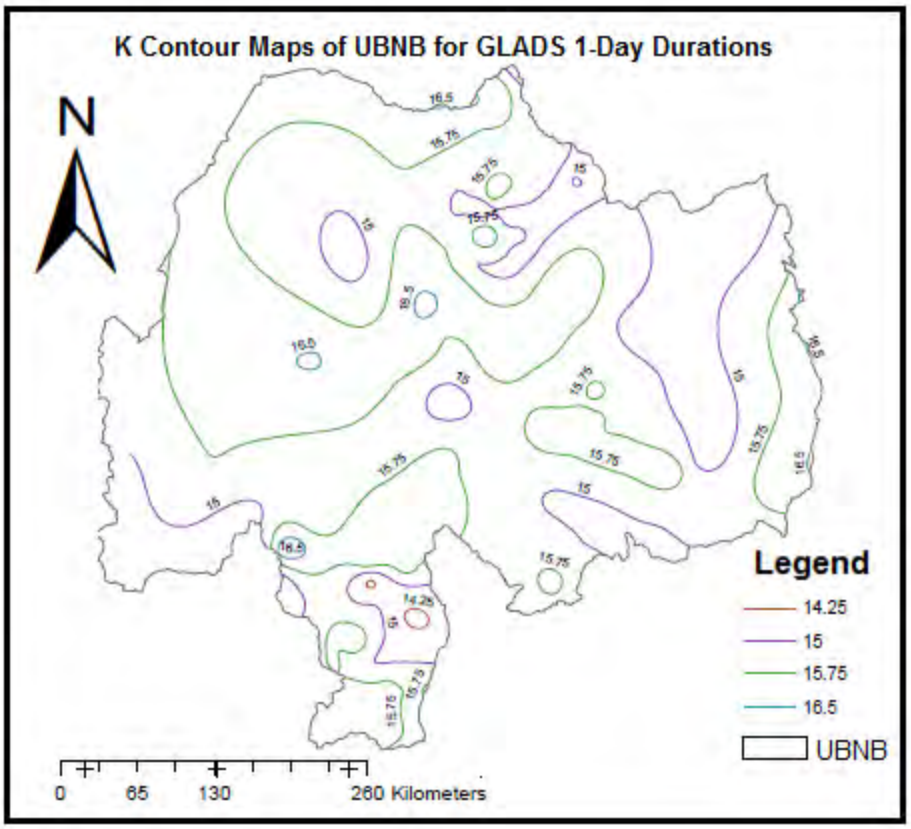

K Contour Maps of UBNB for GLADS 1-Day Durations
N
Legend
14.25
15
15.75
16.5
UBNB
0
65
130
260 Kilometers

Figure H4. PMP (mm) Contour Maps of UBNB reanalysis products using Hershfield's Chart.