

THE DEVELOPMENT OF THE LIMPOPO WATER MANAGEMENT AREA NORTH RECONCILIATION STRATEGY

HYDROLOGICAL ANALYSIS

Supporting Document 1: Rainfall Data Analysis

FINAL

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Authors: **J Lombaard, E van Niekerk and S Sikosana**

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CONSULTANTS: AECOM in association with Hydrosol, Jones & Wagener and VSA Rebotile Metsi Consultants.

Approved for **Consultants**:



FGB de Jager
Task Leader



JD Rossouw
Study Leader

DEPARTMENT OF WATER AND SANITATION (DWS): Directorate: National Water Resources Planning

Approved for **DWS**:



Reviewed: Dr B L Mwaka
Director: Water Resources Planning
Systems



T Nditwani
Acting Director: National Water Planning

Prepared by:

AECOM

AECOM SA (Pty) Ltd
PO Box 3173
Pretoria
0001

In association with:
Hydrosol



Jones & Wagener



VSA Rebotile Metsi Consulting



Limpopo Water Management Area North Reconciliation Strategy

Date: December 2015

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EXECUTIVE SUMMARY

The Limpopo Water Management Area North is the most northern Water Management Area (WMA) in South Africa, and comprises the Matlabas, Mokolo, Lephhalala, Mogalakwena, Sand and Nzhelele River Catchments and forms part of the internationally shared Limpopo River Basin. Mean annual precipitation (MAP) ranges from 300 mm in the north to 700 mm in the Waterberg and Soutpansberg areas. Rainfall is seasonal with most rainfall occurring in the summer. The main rivers form the six major catchment areas. These include the Matlabas (A41), Mokolo (A42), Lephhalala (A5), Mogalakwena (A6), Sand (A7) and Nzhelele (A8) River Catchments.

*The main objectives of the rainfall data analysis as part of the **Limpopo Water Management Area North Reconciliation Strategy** were to:*

- Collate and review available rainfall data sets to update and extend the current rainfall database of the Limpopo WMA North for the study period 1920 to 2010 (i.e. October 1920 to September 2011);*
- Create catchment rainfall data, i.e. monthly time-series representative of the sub-catchment for subsequent use in the hydrological, stochastic and water resource system analysis of the study; and*
- Undertake standard tests to verify that results from the analysis are reliable, realistic and plausible.*

Based on the rainfall data analysis undertaken for this study, the following was concluded:

- Reliable rainfall stations are more sparsely distributed in the northern regions and hence some catchment rainfall records required data from rainfall stations in the adjacent rainfall zones/quaternaries; and*
- The catchment rainfall records of A6B, A6C, A6D and A6E displayed some temporal trends but were considered acceptable as the same pattern was found in all the rainfall stations in close proximity to each other.*
- The Limpopo Monograph and the Mokolo study provided sufficient data that were adjusted where necessary to generate catchment rainfall records for the Limpopo WMA North.*

- *These catchment rainfall records are considered to be reliable, realistic and plausible. These records can be used with confidence in the subsequent hydrological modelling and stochastic and water resource systems analyses of the study.*

The following with regard to the availability of rainfall gauging stations were concluded:

- *Whilst sufficient rainfall stations were available for the analysis purposes, there is a scarcity of reliable rainfall stations in the northern regions of the study area;*
- *The decline in the rainfall network is of concern since only 28 of the 117 (24%) rainfall stations used in the Limpopo Monograph and only 8 of the 33 (24%) used in the Mokolo study, were still operation in 2010.*
- *All stations that were in operation in 2010 are listed in [Table 5.1](#).*

It is recommended that more effort is required for current rainfall data collection as it is essential for reliable and realistic rainfall data analysis.

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LIST OF ABBREVIATIONS

AECOM	AECOM SA (Pty) Ltd
D:NWRP	Directorate: National Water Resource Planning
DM	District Municipality
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
LM	Local Municipality
MAP	Mean Annual Precipitation
MAR	Mean Annual Run-Off
RSA	Republic of South Africa
WMA	Water Management Area
WR90	Water Resources of South Africa - 1990
WR2005	Water Resources of South Africa - 2005
WR2012	Water Resources of South Africa - 2012
WRPM	Water Resources Planning Model
WRSM2000	Water Resources Simulation Model 2000
WRYM	Water Resources Yield Model

1 INTRODUCTION

1.1 APPOINTMENT OF PROFESSIONAL SERVICE PROVIDER (PSP)

The Department of Water and Sanitation (DWS), then Department of Water Affairs (DWA) appointed **AECOM SA (Pty) Ltd** in association with three sub-consultants **Hydrosol, Jones and Wagener** and **VSA Rebotile Metsi Consulting** with effect from 1 March 2014 to undertake the **Limpopo Water Management Area North Reconciliation Strategy**.

1.2 BACKGROUND TO THE PROJECT

The DWS (then DWA) identified a need for the development of the Limpopo Water Management Area (WMA) North Reconciliation Strategy. The Limpopo WMA North refers to the Limpopo WMA described in the first edition of the *National Water Resource Strategy* (NWRS-1) published in 2004. The 19 initial WMAs were consolidated into nine WMAs during 2012 and acknowledged in the second edition of the *National Water Resource Strategy* (NWRS-2) of 2013. The newly defined Limpopo WMA also includes the original Crocodile (West) and Marico WMA as well as the Luvuvhu River catchment, previously part of the Luvuvhu and Letaba WMA. However, these additional areas will not be part of this Reconciliation Strategy.

The Limpopo WMA North comprises of six main river catchments; Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele and are shown in **Figure 1.1**. The very small Nwanedi River catchment forms part of the Nzhelele River catchment. Most of these river catchments rely on their own water resources and are managed independently from neighbouring catchments. This implies that some river catchments require separate and independent reconciliation strategies whilst others need integrated water management reconciliation strategies.

The main urban areas within the WMA include Mokopane, Polokwane, Mookgophong, Modimolle, Lephalale, Musina and Louis Trichardt. Approximately 760 rural communities are scattered throughout the WMA, mostly concentrated in the central region. The main economic activities are irrigation and livestock farming as well as expanding mining operations due to the vast untapped mineral resources in the area. The water resources, especially surface water resources, are heavily stressed due to the present levels of development. It is crucial that water supply is secured and well managed.

The most western area of the Limpopo WMA North, the Matlabas River catchment, is a dry catchment with no significant dams and with a low growth potential for land-use development.

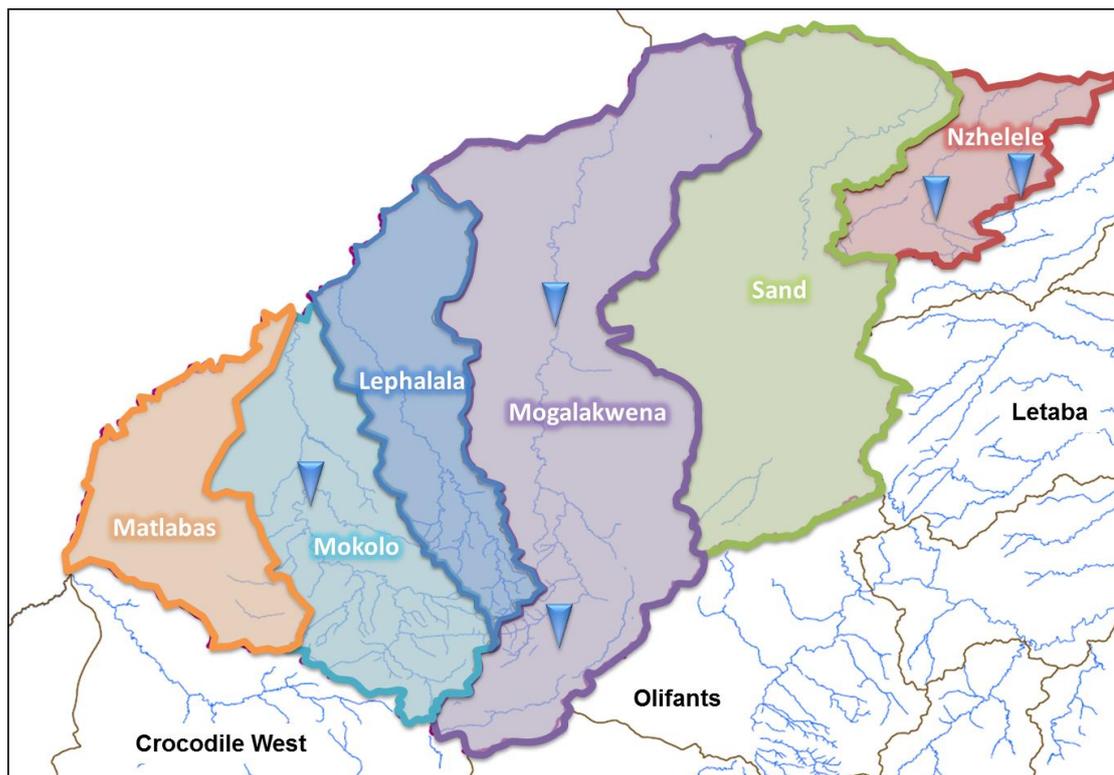


Figure 1.1: Overview of the catchments of the Limpopo WMA North

The large Mokolo Dam, in the Mokolo River catchment, supplies water to the Matimba Power Station, Medupi Power Station, Grootegeluk Coal Mine, the Lephalale Local Municipality (LM) as well as a number of downstream irrigators. The dam is able to meet the bulk of the current requirements but will in future rely on transfers from other WMAs to meet the water requirements at a sufficiently high assurance of supply.

The middle reaches of the Lephalala River catchment have a high conservation value with irrigation activities dominant in the remainder of the catchment. Irrigation in this area is supplied by surface water and alluvial aquifer abstraction.

The bulk of the water resources in the Mogalakwena River catchment have been fully developed. The Doorndraai Dam is over-allocated. Additional water to support the rapid expanding mining activities in the vicinity of Mokopane needs to be augmented by transfers from the Flag Boshielo Dam in the adjacent Olifants River Catchment. Glen Alpine Dam presently supplies water to emerging farmers, who has not yet taken up their full allocated quota, and is expected to supply the growing domestic requirements in future.

Groundwater resources in the Mogalakwena and the Sand river catchments have been extensively utilised, and possibly over-exploited by the dominating irrigation sector. The expanding urban and industrial requirements of Polokwane and Makhado LMs, currently supplied by Albasini Dam, rely heavily on water transfers

from adjacent WMAs. This includes transfers from the Ebenezer Dam, Dap Naude Dam, Flag Boshielo Dam and Nandoni Dam in the Olifants WMA.

Domestic and irrigation water in the small but highly developed Nzhelele River catchment is supplied through the Mutshedzi Dam Regional Water Supply Scheme and the Nzhelele Dam Regional Water Supply Scheme as well as extensively from groundwater resources. The inflows to the Mutshedzi and Nzhelele dams have been reduced as a result of afforestation upstream of these dams. The area is in deficit due to the over-allocation and over development of irrigation.

The Sand and Nzhelele river catchments have high coal mining potential but the availability of local water resources may limit future mining development.

1.3 STUDY AREA

The Limpopo WMA North is the most northern WMA in South Africa and refers to the area described as the Limpopo WMA in NWRS-1. Refer to [Figure 1.2](#) for the location and general layout of the study area. The areas indicated in grey show the additional catchment and WMA areas included in the Limpopo WMA as per NWRS-2 and which do not form part of the study area for this reconciliation strategy.

The Limpopo WMA North forms part of the internationally shared Limpopo River Basin which also includes sections of Botswana, Zimbabwe and Mozambique. The Limpopo River forms the entire length of the northern international border between South Africa and Botswana and Zimbabwe before flowing into Mozambique and ultimately draining into the Indian Ocean. The dry Limpopo WMA North is augmented with transfers from the adjacent Letaba, Olifants and Crocodile West river catchments. No transfers are currently made from the Limpopo WMA North to other WMAs.

The main rivers in the study area, which form the six major catchment areas, are the Matlabas, Mokolo, Lephalala, Mogalakwena, Sand and Nzhelele rivers. These rivers, together with other smaller tributaries, flow northwards and discharge into the Limpopo River.

The climate over the study area is temperate and semi-arid in the south to extremely arid in the north. Mean annual rainfall ranges from 300 mm to 700 mm with the potential evaporation well in excess of the rainfall. Rainfall is seasonal with most rainfall occurring in the summer with thunderstorms. Runoff is low due to the prevalence of sandy soils in the most of the study area, however, loam and clay soils are also found.

The topography is generally flat to rolling, with the Waterberg on the south and the Soutpansberg in the north-east as the main topographic features. Grassland and sparse bushveld shrubbery and trees cover most of the terrain.

The southern and western parts of the WMA are mainly underlain by sedimentary rocks, whilst metamorphic and igneous rocks are found in the northern and eastern parts. With the exception of some alluvium deposits and dolomites near Mokopane and Thabazimbi, these formations are mostly not of high water bearing capacity. The mineral rich Bushveld Igneous Complex extends across the south-eastern part of the WMA, and precious metals are mined at various localities throughout the area. Large coal deposits are found in the north-west.

Several wildlife and nature conservation areas have been proclaimed in the WMA, of which the Nylsvley Nature Reserve, Mapungubwe National Park and the Marekele National Park are probably the best known.

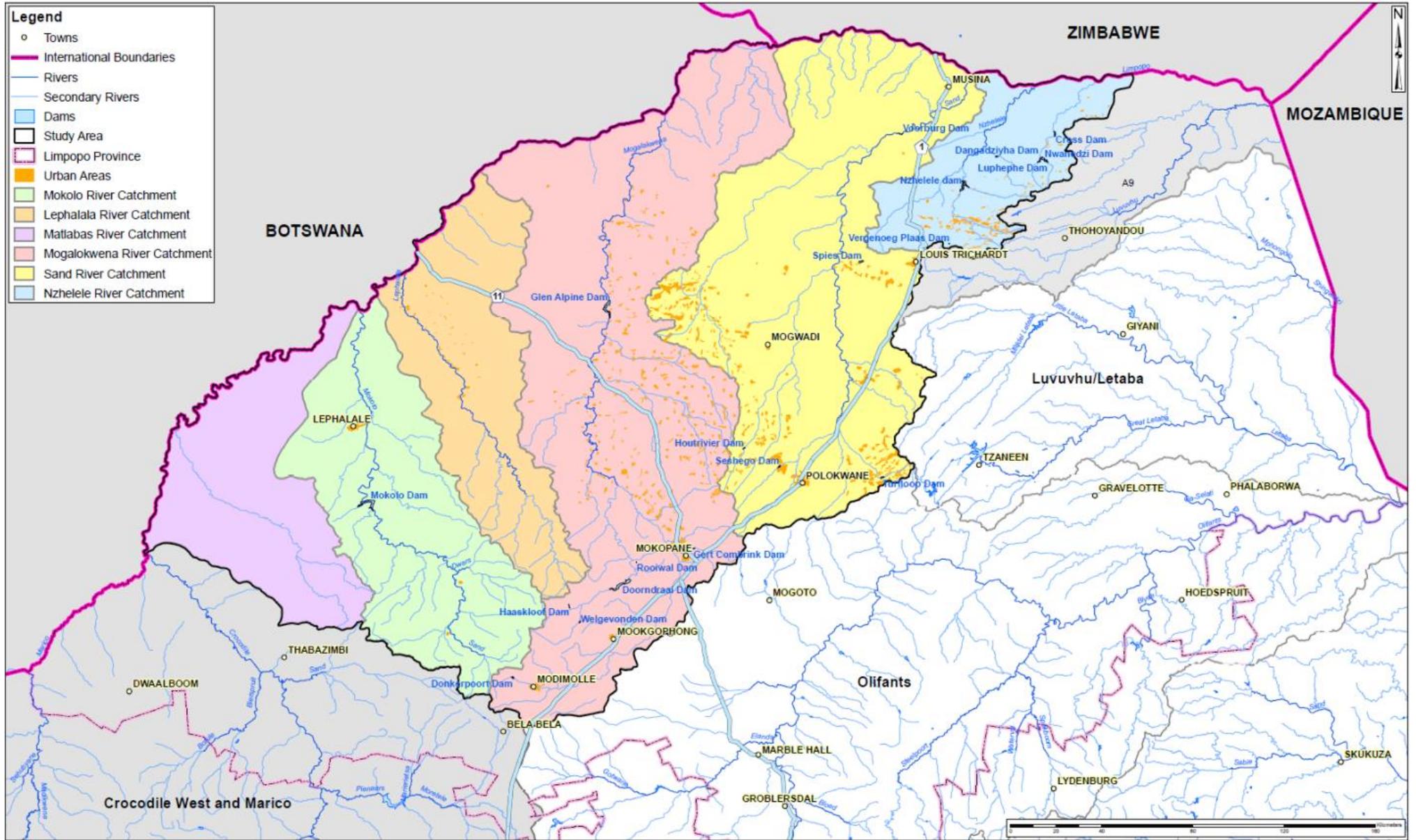


Figure 1.2: General layout of the study area

1.4 MAIN OBJECTIVES OF THE STUDY

The main objective of the study is to formulate a water resource reconciliation strategy for the entire Limpopo WMA North up to 2040. The reconciliation strategy must a) address growing water demands as well as water quality problems experienced in the catchment, b) identify resource development options and c) provide reconciliation interventions, structural and administrative/regulatory. To achieve these objectives, the following aspects are included in the study:

- Review of all available information regarding current and future water requirements projections as well as options for reconciliation;
- Determine current and future water requirements and return flows and compile projection scenarios;
- Configure the system models (WRSM2000 rainfall-runoff catchment model, also known as the Pitman Model, the Water Resources Yield Model (WRYM) and the Water Resources Yield Model (WRPM)) in the study area at a quaternary catchment scale, or smaller, where required, in a manner that is suitable for allocable water quantification. This includes updating the hydrological data and accounting for groundwater surface water interaction;
- Assess the water resources and existing infrastructure and incorporate the potential for Water Conservation and Water Demand Management (WCWDM) and water reuse as reconciliation options; and
- Develop a preliminary short-term reconciliation strategy followed by a final long-term reconciliation strategy.

1.5 SCOPE OF THIS REPORT

The purpose of this report is to outline the methodology adopted to review, adjust and update the rainfall database of the Limpopo WMA North.

The objectives of this report are to collate, evaluate and update recent rainfall studies in the Limpopo WMA North to compile a rainfall database representative of the relevant sub-catchments for subsequent use in the hydrological, stochastic and water resources system analysis under the different tasks of this study.

This report describes how previous hydro-meteorological studies were utilised, evaluated, updated and extended to meet the objectives of this task. It should be noted, that the rainfall report will only be finalised once the calibration of the stream flow has been completed. This is to make provision for the possible re-analysis if outliers or inconsistencies between rainfall data and observed stream flows are detected during the WRSM2000 calibration process.

2 BACKGROUND AND OBJECTIVES OF RAINFALL ANALYSIS

2.1 GENERAL

Rainfall data are the fundamental driver of hydrological modelling. Rainfall data are critical to the successful modelling of the long-term runoff from a catchment through the use of a rainfall-runoff model, calculating irrigation requirements and modelling of groundwater infiltration. The output from the rainfall data analysis will form the input to the subsequent hydrological and water resources system analyses.

The rainfall data analysis was the initial step in generating the hydrology of the Limpopo WMA North. The objectives for the rainfall data analysis were as follow:

- Collect and review rainfall records from previous studies and existing databases within the study area and if necessary, patch raw rainfall records;
- Update and extend the rainfall database for the hydrological years 1920 to 2010 (October 1920 to September 2011);
- Develop monthly time-series of catchment rainfall records for subsequent use in the hydrological, stochastic and water resources system analysis of the study; and
- Undertake standard tests to verify that the results from the analysis are reliable, realistic and plausible.

2.2 PREVIOUS STUDIES WITHIN THE LIMPOPO WMA NORTH

A number of hydro-meteorological studies have previously been conducted in the study area. A summary of these studies is provided in [Table 2.1](#), with an explanation of the worth of this data for inclusion in this study.

Table 2.1: Previous rainfall studies in the Limpopo WMA North

No.	Study	Consultant	Date of Study	Rainfall Analysis and Data availability
1	Water Resources of South Africa - 2005	WRC	2005	Rainfall data available for the period 1920 to 2004 (hydrological years). Data used as a good starting point for rainfall data analysis.
2	Updating the Hydrology and Yield Analysis in the Mokolo River Catchment	WRP	2007	Rainfall data available for the period 1920 to 2003 (hydrological years). The study includes a very detailed analysis of the catchment and data is considered to be very reliable, realistic and plausible.
3	Establishment of operating rules for the Glen Alpine system: Volume 2 of 6 Rainfall and hydrological analysis	Royal Haskoning (formerly SSI)	2011	Based on the WR2005 rainfall data which was extended to the 2007 hydrological year.
4	The Limpopo River Basin Monograph	Aurecon	2013	WR2005 rainfall used and extended to the 2010 hydrologic year for all the river catchments included in the study area. Rainfall data for the Mokolo and Mogalakwena River Catchments were used from the studies numbered as 2 and 3 respectively and extended to 2010.
5	Water Resources of South Africa - 2012	WRC	In progress	Rainfall data available for the period 1920 to 2009 (hydrological years). Study due for completion in April 2016.

For ease of reference, the *Limpopo River Basin Monograph* (Howard, Denys, Walker, & Gorgens, 2013) is referred to as the “Limpopo Monograph” and the *Updating the Hydrology and Yield Analysis in the Mokolo River* (WRP Consulting Engineers, 2007) study is referred to as the “Mokolo study” in the remainder of this report.

2.3 METHODOLOGY

The following methodology has been applied in the rainfall data analysis and will be described in detail in the following chapters:

- Collate all available rainfall data, including catchment rainfall records from previous studies;
- Evaluate these catchment rainfall records for reliability and stationarity by means of visual inspection and statistical analyses;
- Where necessary, extend rainfall data to include the analysis period 1920 to 2010 (hydrological years) using patched point rainfall data available from other studies;

- Where existing catchment rainfall records are suspect, inspect the individual point rainfall stations used to create this catchment record and exclude unreliable and short records;
- Update catchment rainfall files with improved data;
- Evaluate the final catchment records for reliability and stationarity;
- Adjust catchment MAP values to ensure that overlapping rainfall record periods are identical to that of the WR2005;
- Generate catchment rainfall files (.sec files as a percentage of the MAP); and
- Generate catchment rainfall files (.ran files in mm).

3 DATA COLLECTION AND COLLATION

Approximately 496 rainfall gauging stations are located in the Limpopo WMA North with an additional 209 rainfall gauging stations in the adjacent WMAs in close proximity to the Limpopo WMA North. The spatial distribution of rainfall stations is better in the higher rainfall regions along the south eastern borders of the WMA with a marked decrease in the number of rainfall stations as the climate becomes more arid towards the Limpopo River in the west.

Due to the large number rainfall stations and many recent rainfall data studies, initially only the existing catchment rainfall records (as a percentage of the MAP) were evaluated through visual inspection and basic statistical analysis. Individual point rainfall data time series were analysed only in isolated cases with critical problems in the catchment rainfall records. A list of all the rainfall stations inside and adjacent to the Limpopo WMA North, with an indication of the stations used in previous studies, are provided in [Appendix A \(Table A.1 and Table A.2\)](#).

3.1 RAINFALL DATA FROM OTHER STUDIES

Catchment rainfall records as well as patched point rainfall data sets were sourced from the *Limpopo Monograph* and the *Mokolo Study*.

The *Limpopo Monograph* matches the intended record period of this study and was consequently selected to form the basis of the Limpopo WMA North rainfall data analysis. The *Limpopo Monograph* incorporated the data of all the earlier studies listed in [Table 2.1](#). It used, as far as possible, similar rainfall station groupings as the earlier studies to extend the catchment rainfall records to 2010. It is important to note that the *Limpopo Monograph* catchment rainfall records were generated per rainfall zone as a percentage of the MAP.

The *Limpopo Monograph* used catchment rainfall records from previous rainfall studies. The relevant catchments and the associated study from which data were obtained are summarised in [Table 3.1](#).

Table 3.1: Summary of studies used per catchment for the Limpopo River Basin Monograph

Catchment name	Secondary/Tertiary catchment number	Base study
Matlabas	A41	WR2005
Mokolo	A42	Updating the Hydrology and Yield Analysis in the Mokolo River Catchment
Lephalala	A5	WR2005
Mogalakwena	A6	Establishment of Operating Rules for the Glen Alpine System
Sand	A7	WR2005
Nzhelele	A8	WR2005

Rainfall data from the *Mokolo study* were sourced to form the basis of the rainfall analysis of the Mokolo River Catchment. From the *Literature Review Report (P WMA 01/000/00/02914/2)*, it was concluded that the study was done to a high level of detail. Initial screening of the available data showed the catchment rainfall records to be reliable. This was confirmed at a later stage as part of this rainfall data analysis.

4 CATCHMENT RAINFALL RECORDS

Rainfall zones in the Limpopo WMA North were grouped by previous studies, based on:

- The spatial and temporal distribution of acceptable complete point rainfall stations and the associated rainfall station's MAPs;
- Isohyets of Mean Annual Precipitation (MAP); and
- Quaternary catchments (only for the *Mokolo study*).

The Limpopo WMA North was grouped into 19 rainfall zones. These zones are indicated in [Figure D.1](#) of [Appendix D](#). It should be noted that the rainfall data analysis of the *Mokolo study* were done per quaternary catchment and in far more detail than the other studies. The nine Mokolo quaternary catchments were therefore not changed to rainfall zones and it should be noted that a rainfall zone of the Mokolo River Catchment refers to the quaternary catchment.

4.1 INITIAL SCREENING OF CATCHMENT RAINFALL RECORDS

Catchment rainfall records from the *Mokolo study*, for the Mokolo River Catchment, and from the *Limpopo Monograph*, for the remainder of the rainfall zones in the Limpopo WMA North were screened by means of visual assessment and standard validation tests known as “single mass plots” and “cusum plots” for any anomalies in the records.

Single mass plots are graphs of cumulative annual rainfall plotted against time and give an indication of the consistency of the data. Ideally the mass plot for a station should form a straight line, indicating stationary data. Cyclic deviations from this line indicate wetter and drier periods. Any significant change in the gradient of the mass plot indicates a change in continuity at the station. Breaks are usually caused by external factors, for example relocating of the gauging station or a change to the surroundings. If two or more trends with different gradients can be identified, it may indicate that the data are not stationary. This data must either be discarded or split into more than one stationary component, which must be treated as two separate records.

Cusum plots represent the cumulative difference of the annual totals from the mean. This test is very sensitive to the occurrence of trends in data sets and may be used to identify the point in time when a discontinuity occurs.

From the consistent mass and cusum plots, it was concluded that the catchment rainfall records obtained from the *Mokolo study* required no re-evaluation of point rainfall data or re-grouping of catchment rainfall records. The only additional requirement was to extend the point rainfall data and subsequent catchment

rainfall records from 2003 to 2010 (hydrological years). The extension was done using the results from the *Limpopo Monograph* for the period October 2004 to September 2011.

However, the majority of the catchment rainfall records from the *Limpopo Monograph* (excluding the Mokolo River Catchment) showed non-stationary plots with obvious trends in the rainfall records. It was therefore necessary to regenerate all these catchment rainfall records to identify the underlying problem. Where required the catchment rainfall records were adjusted with different groupings of rainfall records and re-evaluated for stationarity.

The initial single mass and cusum plots of the catchment rainfall record of rainfall zone A7B are shown as examples of non-stationary plots with obvious trends (Figure 4.1 and Figure 4.2).

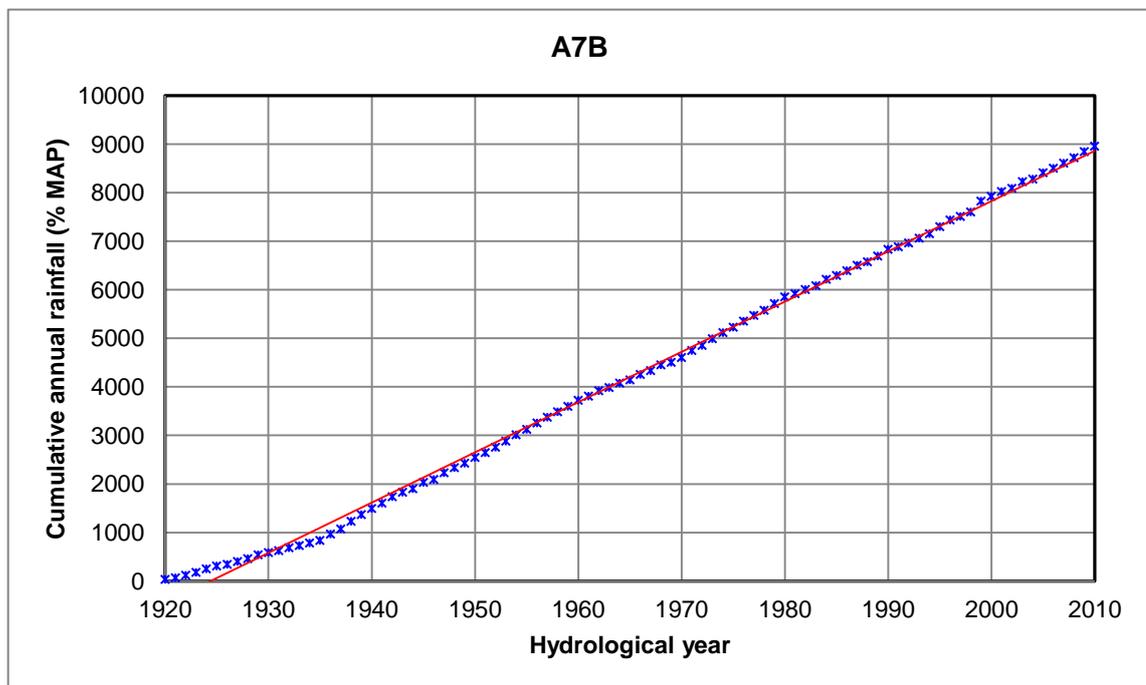


Figure 4.1: Initial A7B catchment rainfall single mass plot

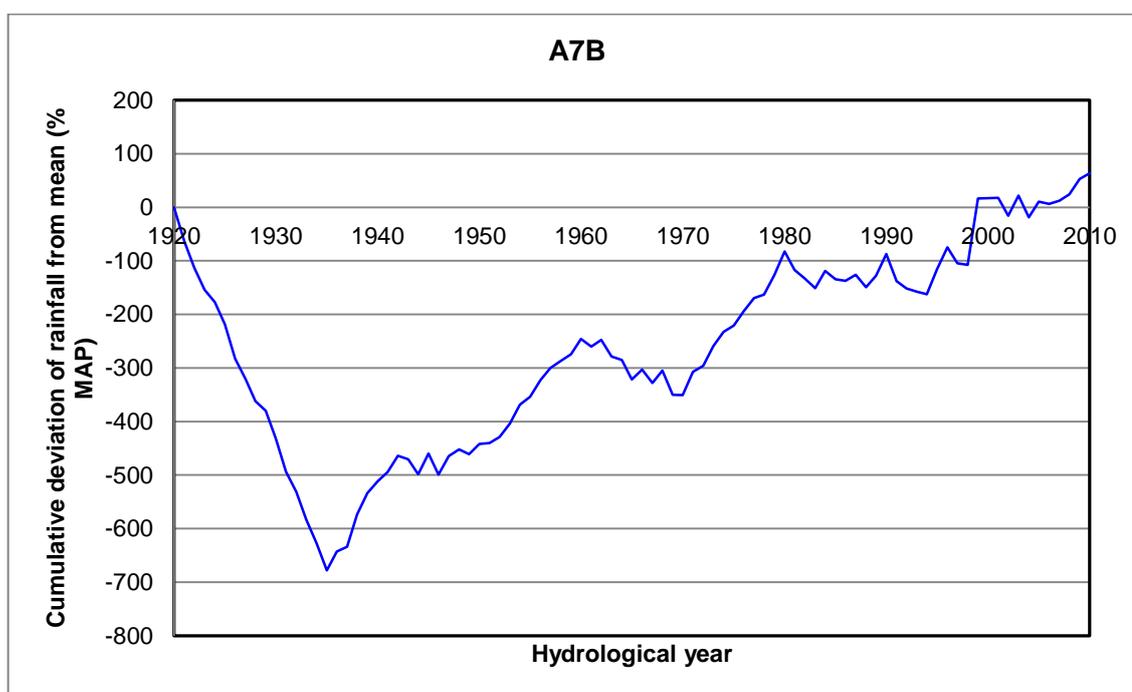


Figure 4.2: Initial A7B catchment rainfall cusum plot

4.2 ADJUSTING EXISTING CATCHMENT RAINFALL RECORDS (LIMPOPO MONOGRAPH EXCLUDING MOKOLO STUDY)

Due to the non-stationary of the *Limpopo Monograph* catchment rainfall records, the catchment rainfall data sets of the *Limpopo Monograph*, excluding the catchment rainfall records from the *Mokolo study*, were regenerated using the individual point rainfall data and identical rainfall station groupings previously used in the *Limpopo Monograph* and associated studies.

The regenerated single mass and cusum plots differed significantly from the initial plots. The number of rainfall stations included in a particular rainfall zone was found to be excessive, which resulted in “smoothed” catchment rainfall sets which do not reflect the high and low rainfall adequately. The criteria for catchment rainfall records are to include at least two rainfall stations, but no more than four in any given period, with a maximum total of eight stations per rainfall over the full record period.

The individual patched point rainfall records were reviewed and all suspect rainfall stations were excluded from the groupings of the rainfall zones. Rainfall data shorter than 15 years were also excluded from the study. Records with suspect periods of rainfall records were split and only the reliable records periods were included in the catchment records. Caution was taken not to discard any point rainfall data where it is the only data covering a certain period, irrespective of the record length.

Examples of this include the following rainfall gauging stations:

- 0720 727 W used in rainfall zone A6F – containing 6 years of data; and
- 0766 150 W used in rainfall zone A8A and A8B – containing 12 years.

Both these rainfall stations cover the record periods between 1920 and 1931 (0720 727 W from 1920 to 1925 and 0766 150 W from 1920 to 1931). During this period very little rainfall records exist in this area.

Adjusted catchment rainfall records, as a percentage of the associated MAP, were regenerated taking into consideration the spatial and temporal patterns of available records.

5 RESULTS

5.1 CATCHMENT RAINFALL GROUPINGS

Table B.1 in **Appendix B** shows the temporal availability of the point rainfall station records as bar charts per rainfall zone that were included in the *Limpopo Monograph* to generate the existing catchment rainfall records. The rainfall stations that were excluded for updating the *Limpopo Monograph* catchment rainfall records, is indicated as grey blocks with a diagonal line.

In total, 117 rainfall stations' data from the *Limpopo Monograph* was evaluated to adjust the catchment rainfall. It was necessary to exclude 25 rainfall records with portions removed from a further 10 rainfall records.

Table C.1 in **Appendix C** provides a list of the rainfall station and their record periods used in the *Limpopo Monograph*, record periods excluded and the record period used for the purpose of this study.

Table B.2 in **Appendix B** shows the availability of all the rainfall stations' records in the form of bar charts, per quaternary catchment, that were included in the *Mokolo study*, and hence in this study. The extension of rainfall stations to 2010 are indicated with grey blocks. In total, 33 point rainfall gauging stations' data in the Mokolo River Catchment were used to generate the catchment rainfall records for the Mokolo River Catchment. Eight of these rainfall gauging stations were also included in the 117 used for the remainder of the study area. Ten rainfall stations in the *Mokolo study* were extended from 2004 to 2010, using the *Limpopo Monograph* data.

Table C.2 in **Appendix C** provides a list of the rainfall gauging stations and their respective record periods used in the *Mokolo study*. This includes the stations that were extended to 2010.

The spatial rainfall station coverage with the rainfall isohyets are shown in **Figure D.1** of **Appendix D**, indicating the rainfall gauging stations used to generate the adjusted catchment rainfall records for this study (red dots) and also the rainfall stations excluded (white dots). The map shows a scarcity of rainfall stations in the drier northern regions of the study area. This necessitated rainfall stations outside the Limpopo WMA North to be included in some of the groupings of the catchment rainfall. Far more point rainfall data, with longer record lengths, are available in the south western Waterberg area compared to data in the drier regions. This implies a better availability of stations per rainfall zone and ultimately a wider selection of stations with good and reliable data.

The catchment rainfall records generated for the rainfall zones and the quaternary catchments, in the case of the Mokolo River Catchment, are

presented in [Appendix E](#) (*.sec files). These catchment rainfall records are expressed as a percentage of the relevant MAP. The final single mass and cumsum plots for each catchment rainfall record are also provided in [Appendix E](#).

Catchment rainfall records of A6B, A6C, A6D and A6E displayed similar trends and temporal patterns which differed from adjacent rainfall patterns. These records were however considered acceptable as the associated rainfall zones are located in the same catchment, namely the Mogalakwena River Catchment. Furthermore all point rainfall stations used to collate these catchment rainfall records displayed similar trends and temporal patterns.

5.2 ADJUSTED CATCHMENT MEAN ANNUAL PRECIPITATION VALUES

The MAPs of the newly extended and updated catchment rainfall records for the hydrological years 1920 to 2010 per rainfall zone were adjusted to reflect the WR2005 MAPs over the hydrological years 1920 to 1989. This adjustment was necessitated to ensure that the flow records, that will be extended with the WRSM2000 model using the extended catchment rainfall in subsequent tasks of this study, is potentially identical to that used in the *Limpopo Monograph* and the *Mokolo study*. This procedure was repeated for all the catchment rainfall records, even where the rainfall was changed for the shorter period to be consistent in approach in generating the catchment rainfall records.

[Table F.1](#) in [Appendix F](#) provides the quaternary WR2005 catchment MAPs, MAP adjustment factors and final catchment MAPs adopted for the period 1920 to 2010.

5.3 GENERATION OF MODEL CATCHMENT RAINFALL FILES

The rainfall percentage files (*.sec) are similar to the generated catchment rainfall records where the monthly rainfall are expressed as a percentage of the relevant MAP. The rainfall files (*.ran) are generated from the catchment rainfall records where the monthly rainfall are expressed in mm. These files will be used in the subsequent hydrological, stochastic and water resource system analysis, which forms part of the study.

5.4 AVAILABILITY OF RAINFALL RECORDS

Approximately a quarter (24%) of the number of rainfall stations that were used in this study remained open until 2010. Only 28 of the 117 rainfall stations used in the Limpopo Monograph, and eight of the 33 used in the Mokolo study were still open in 2010. The spatial distribution of the stations open at the end of 2010 (hydrological year), is shown in [Figure 5.1](#). The quaternary and the record period of each station are provided in [Table 5.1](#).

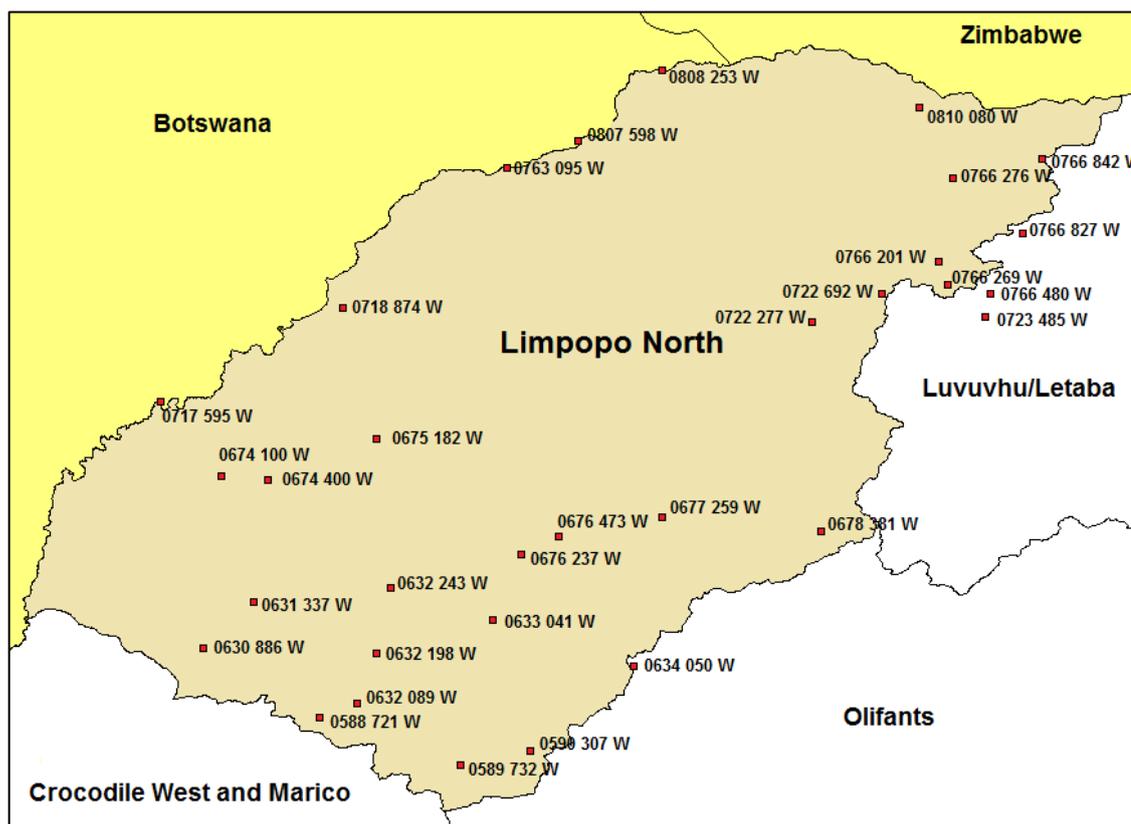


Figure 5.1: Spatial distribution of rainfall stations open until and after 2010

Few rainfall stations are still operational in the middle and upper reaches of the Mogalakwena and Sand River Catchments and only two rainfall stations are open in the Matlabas River Catchment. More effort is required for current rainfall data collection as it is essential for reliable and realistic rainfall data analysis.

Table 5.1: Rainfall stations open until and after 2010

SAWS No.	Quaternary	Period available (Years)		
		Start	End	Length (Until 2010)
0588 721 W	A42B	1916	Still open	95
0589 732 W	A61A	1902	Still open	109
0590 307 W	A61C	1916	Still open	95
0630 886 W	A41A	1936	Still open	75
0631 337 W	A42F	1968	Still open	43
0632 089 W	A42B	1947	2010	64
0632 198 W	A42C	1948	Still open	63
0632 274 W	A42G	1934	Still open	77
0633 041 W	A50B	1983	Still open	28
0634 050 W	B51E	1923	Still open	88
0674 100 W	A42J	1975	Still open	36
0674 400 W	A42H	1967	Still open	44
0675 182 W	A50G	1908	Still open	103
0676 237 W	A62A	1940	Still open	71
0676 473 W	A62B	1985	Still open	26
0677 259 W	A62E	1920	Still open	91
0678 381 W	A71B	1948	Still open	63
0717 595 W	A41E	1924	Still open	87
0718 874 W	A50H	1931	2010	80
0722 277 W	A71H	1919	Still open	92
0722 721 W	A71H	1912	Still open	99
0763 124 W	A63C	1963	Still open	48
0766 201 W	A80B	1965	Still open	46
0766 269 W	A80A	1985	2010	26
0766 276 W	A80G	1959	Still open	52
0766 480 W	A91E	1922	Still open	89
0766 827 W	A92A	1953	Still open	58
0766 842 W	A80J	1954	2010	57
0807 598 W	A63C	1982	Still open	29
0808 253 W	A63E	1965	Still open	46
0809 706 W	A71L	1919	Still open	92
0810 081 W	A71K	1965	Still open	46

6 CONCLUSIONS AND RECOMMENDATIONS

Based on the rainfall data analysis undertaken as part of the *Limpopo Water Management Area North Reconciliation Strategy*, it was concluded that:

- The existing catchment rainfall records from the *Limpopo River Basin Monograph* (hydrological years 1920 to 2010) and the *Updating the Hydrology and Yield Analysis in the Mokolo River Catchment* (hydrological years 1920 to 2003) formed the base of this study;
- Catchment rainfall records from the *Mokolo study* was found to be of high confidence and was extended without change to 2010, using patched point rainfall data from the *Limpopo Monograph* and keeping the original rainfall station groups. In total 33 rainfall stations, of which ten was extended, were used for the generation of the Mokolo River Catchment's rainfall records;
- Some of the catchment rainfall records from the *Limpopo Monograph* were not stationary. Therefore the point rainfall data were reviewed and all suspect and superfluous rainfall stations (too many stations in a group) were excluded before generating the adjusted catchment rainfall records. In total, 117 rainfall stations' data were reviewed, of which 25 stations were completely removed from the zone group and 10 additional stations were included;
- Reliable rainfall stations in the northern regions are sparse and it was therefore necessary to include some catchment rainfall records from adjacent WMA's;
- Based on standard tests, such as the cusum plots, catchment rainfall records of A6B, A6C, A6D and A6E displayed similar trends and temporal patterns which differed from adjacent rainfall patterns. These records were however considered acceptable as the associated rainfall zones are located in the same catchment, namely the Mogalakwena catchment. Furthermore all point rainfall stations used to collate these catchment rainfall records displayed similar trends and temporal patterns.
- Catchment rainfall records were considered reliable, realistic and plausible and therefore adequate for application in the subsequent hydrological, stochastic and water resource systems analyses which form part of the study.

However, whilst sufficient rainfall stations were available for analysis, there is concern with regards to the density of the rainfall stations of reliable data in the northern regions of the study area. It is recommended that more effort is required for current rainfall data collection, especially since only 24% of the rainfall stations used in the *Limpopo Monograph* and the *Mokolo study* was still open in 2010.

7 REFERENCES

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Appendix A

Rainfall stations within and in close proximity to the Limpopo WMA North

Table A.1: List of rainfall stations in the Limpopo WMA North

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
1	0588 573 W	A42B	KLIPRIVIER	-24°32'	27°50'	1921	1952	32	31	8.1		X	X
2	0588 721 W	A42B	RANKINS PASS	-24°32'	27°55'	1916	2008	93	45	4	X	X	X
3	0588 782 W	A42B	KLIPDRIFT	-24°33'	27°56'	1926	1927	2	5	20.8			
4	0588 845 W	A42B	WELTEVREDEN	-24°35'	27°58'	1919	1944	26	68	21.8			
5	0589 156 W	A42B	DE NOUTE	-24°36'	28° 6'	1950	1968	19	10	4.4			
6	0589 183 W	A42A	ALMA - DIE LAASTE WATERG	-24°33'	28° 7'	1984	1989	6	21	29.2			
7	0589 186 W	A42A	RIETFONTEIN	-24°35'	28°14'	1902	1920	19	39	17.1			
8	0589 342 W	A42A	GEMSBOKPOORT	-24°42'	28°12'	1903	1952	50	45	7.5	X	X	X
9	0589 366 W	A42A	MIDDELFONTEIN	-24°35'	28°14'	1941	1948	8	14	14.6			
10	0589 371 W	A42A	GEMSBOKPOORT	-24°41'	28°13'	1949	2006	58	25	3.6	X	X	X
11	0589 456 W	A42A	WATERFORD	-24°36'	28°16'	1920	1940	21	24	9.5			
12	0589 460 W	A61A	VAALKOP	-24°40'	28°16'	1906	1944	39	28	6			
13	0589 503BW	A61A	WARMBAD - SAR	-24°43'	28°17'	1904	1925	22	42	15.9			
14	0589 543 W	A42A	DOORNFONTEIN	-24°33'	28°20'	1924	1977	54	32	4.9		X	X
15	0589 550 D	A61A	A6E006 Donkerpoort @ Donkerpoort Dam	-24°40'	28°19'	1977	2003	27	27	8.3			
16	0589 586 W	A61A	BUFFELSPOORT	-24°46'	28°20'	1932	1979	48	12	2.1	X	X	X
17	0589 615 W	A61A	MODDERPOORT	-24°46'	28°21'	1904	1910	7	15	17.9			
18	0589 670 W	A61A	ELANDSPOORT	-24°40'	28°22'	1912	1993	82	54	5.5	X	X	X
19	0589 732 W	A61A	NYLSTROOM	-24°42'	28°25'	1902	2007	106	665	52.3			X
20	0589 732AW	A61A	NYLSTROOM - MUN	-24°42'	28°25'	1948	2008	61	47	6.4	X		
21	0589 761 W	A61B		-24°41'	28°26'	1939	1949	11	23	17.4			
22	0589 761AW	A61B		-24°41'	28°26'	1951	1953	3	6	16.7			
23	0589 766 W	A61A	VYGEBOOMSPOORT	-24°46'	28°26'	1905	1931	27	46	14.2	X		X
24	0589 828 W	A61C	SYFERFONTEIN	-24°48'	28°28'	1986	1998	13	5	3.2			
25	0589 877 W	A61B	GROENFONTEIN	-24°38'	28°29'	1903	1977	75	56	6.2	X	X	X
26	0589 881 W	A61B	OLIFANTSPOORT	-24°41'	28°30'	1931	1937	7	11	13.1			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
27	0590 106 W	A61C	VARKENSKUIL 11	-24°46'	28°33'	1908	1952	45	17	3.1	X		X
28	0590 106AW	A61C	VARKENSKUIL 1	-24°45'	28°35'	1926	1941	16	29	15.1			
29	0590 184 W	A61D	VISCHGAT	-24°33'	28°38'	1964	1975	12	3	2.1			
30	0590 214 W	A61C	BADSLOOP	-24°35'	28°38'	1923	1932	10	13	10.8			
31	0590 222 W	A61C	NUM NUM	-24°42'	28°38'	1903	1952	50	43	7.2			
32	0590 245 W	A61C	NOOITGEDACHT	-24°34'	28°39'	1928	1962	35	16	3.8	X		
33	0590 248 W	A61C	BOEKENHOUT	-24°38'	28°39'	1921	1930	10	25	20.8			
34	0590 252 W	A61C	DEELKRAAL	-24°42'	28°39'	1913	1947	35	58	13.8			
35	0590 276 W	A61C	VOGELFONTEIN	-24°37'	28°43'	1922	1952	31	35	9.4			
36	0590 282 W	A61C	BEESTEPOORT	-24°43'	28°38'	1912	1953	42	36	7.1			
37	0590 307 W	A61C	NYLSVLEY	-24°39'	28°40'	1916	2008	93	44	3.9	X		X
38	0590 342 W	A61C	BLINDEFONTEIN	-24°43'	28°43'	1910	1947	38	41	9			
39	0590 361 W	A61D	NABOOMSPRUIT - POL	-24°31'	28°43'	1903	2008	106	73	5.7	X		X
40	0590 422 W	A61D	GROOTVLEI	-24°32'	28°45'	1909	1942	34	33	8.1			
41	0590 454 D	A61D	A6E005 Du Toits Kraal @ Nylvlei	-24°34'	28°46'	1970	2007	38	20	4.4			
42	0590 486 W	A61D	MOSDENE	-24°36'	28°47'	1928	1993	66	18	2.3	X		X
43	0630 276 W	A41D	KRUISPAN	-24° 6'	27°10'	1958	1966	9	12	11.1			
44	0630 391 W	A41C	SOMERSET NORTH	-24° 1'	27°14'	1933	1942	10	12	10			
45	0630 511 W	A41C	ELYSIUM	-24° 1'	27°19'	1957	1998	42	13	2.6	X	X	X
46	0630 556 W	A41D	GROENVLEI - SKL	-24°16'	27°19'	1933	2001	69	22	2.7			
47	0630 616 W	A41D	SENTRUM-YSTERPAN	-24°16'	27°21'	1919	2007	89	23	2.2			
48	0630 826 W	A41A	GROENRIVIER	-24°15'	27°29'	1925	1969	45	21	3.9	X		
49	0630 862 W	A41A	BLAAUWPAN	-24°21'	27°30'	1941	1947	7	25	29.8			X
50	0630 886 W	A41A	HOOPDAL - POL	-24°17'	27°30'	1936	2008	73	32	3.7	X		X
51	0631 011 W	A41B	HOPEWELL	-24°11'	27°32'	1922	1984	63	58	7.7	X	X	X
52	0631 047 W	A41A	KLIPDRIFT	-24°18'	27°32'	1925	1981	57	23	3.4	X		X
53	0631 115 W	A41A	AAPIESRIVIERPOORT	-24°25'	27°33'	1930	1945	16	40	20.8			
54	0631 131 W	A41B	DIAMOND V RANCH	-24°14'	27°35'	1936	1977	42	37	7.3			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
55	0631 265 W	A41A	MAMIAANSHOEK	-24°24'	27°41'	1909	1920	12	13	9			
56	0631 335 W	A42F	MOOIFONTEIN	-24° 4'	27°41'	1928	1978	51	409	66.8			
57	0631 337 W	A42F	BULGERIVIER - POL	-24° 7'	27°41'	1968	2008	41	18	3.7	X	X	X
58	0631 487 W	A42F	LAASTEGEVONDEN	-24° 6'	27°47'	1914	1937	24	27	9.4	X	X	
59	0631 510 W	A42B	KLIPSPRUIT	-24°30'	27°46'	1926	1939	14	15	8.9			
60	0631 520 W	A42F	HERMANUSDOORNS	-24°10'	27°48'	1904	1952	49	41	7			X
61	0631 564 W	A42D	ELANDSHOEK	-24°24'	27°49'	1911	1977	67	59	7.3		X	X
62	0631 596 W	A42D	STERKFONTein	-24°26'	27°50'	1912	1980	69	24	2.9	X	X	X
63	0631 630 W	A42B	RHENOSTERPOORT	-24°29'	27°50'	1903	1926	24	36	12.5	X		
64	0631 745 W	A42D	ZUIKERBOSCHFONTEIN	-24°23'	27°56'	1925	1938	14	52	31			
65	0631 778 W	A42B	RIETVLEI	-24°29'	27°56'	1928	1948	21	17	6.7			
66	0631 791 A	A42E	13A4E02 GROENDRAAI	-24°11'	27°57'	1957	1971	15	12	6.7			
67	0631 791 D	A42E	A4E002 Groendraai	-24°11'	27°57'	1957	1970	14	14	8.3			
68	0631 791 W	A42E	GROENDRAAI	-24°11'	27°57'	1960	1970	11	11	8.3			
69	0631 823 D	A42E	A4E005 Doorn Spruit	-24°13'	27°58'	1965	1973	9	3	2.8			
70	0631 823 W	A42E	DOORNSPRUIT	-24°13'	27°58'	1970	1973	4	10	20.8			
71	0632 006 W	A42E		-24° 6'	28° 1'	1948	1948	1	11	91.7			
72	0632 044 D	A42E	A4E006 Goedehoop	-24°14'	28° 2'	1973	1979	7	11	13.1			
73	0632 044 W	A42E	GOEDEHOOP	-24°16'	28° 2'	1949	1995	47	14	2.5	X	X	X
74	0632 062 W	A42G	RIETBOKHOEK	-24° 2'	28° 3'	1918	1947	30	15	4.2	X	X	X
75	0632 077 A	A42E	VAALWATER.	-24°17'	28° 3'	1978	1990	13	36	23.1			
76	0632 089 W	A42B	KOPPIE ALLEEN	-24°29'	28° 3'	1947	2007	61	34	4.6	X	X	X
77	0632 119 W	A42A	ALMA	-24°29'	28° 4'	1931	1945	15	44	24.4			
78	0632 137 W	A42C	ZANDRIVIER	-24°18'	28° 5'	1917	1950	34	28	6.9	X	X	X
79	0632 167 D	A42C	A4E001 Vaal Water	-24°17'	28° 6'	1953	2004	52	23	3.7			
80	0632 198 W	A42C	VAALWATER - POL	-24°18'	28° 7'	1948	2008	61	29	4	X	X	X
81	0632 234 W	A42C	ZANDRIVIERPOORT	-24°24'	28° 7'	1903	1931	29	29	8.3		X	
82	0632 243 W	A42G	BRAKFONTEIN	-24° 4'	28°10'	1903	1936	34	12	2.9		X	

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
83	0632 274 W	A42G	DORSET - POL	-24° 4'	28°10'	1934	2008	75	42	4.7	X	X	X
84	0632 297 W	A42C	BOEKENHOUTKLOOF	-24°27'	28°10'	1910	1974	65	43	5.5	X	X	X
85	0632 312 W	A42E	NOOITGEDACHT	-24°13'	28°10'	1931	1941	11	5	3.8			
86	0632 406 W	A42E	WITKLIP	-24°17'	28°14'	1961	2000	40	21	4.4	X	X	X
87	0632 410 W	A42E	GEMSBOKFONTEIN	-24°21'	28°14'	1926	1953	28	12	3.6		X	X
88	0632 428 W	A42E	KROKODILRIVIER	-24° 9'	28°16'	1931	1948	18	24	11.1			
89	0632 465 W	A42E	TWENTY-FOUR RIVERS	-24°16'	28°17'	1903	1952	50	26	4.3	X		X
90	0632 561 W	A42E	HIGHLANDS	-24°21'	28°19'	1918	1925	8	9	9.4			
91	0632 614 W	A50C	KAMEELFONTEIN	-24°14'	28°21'	1968	1975	8	17	17.7			
92	0632 671 W	A50C	PAARDEDRIFT	-24°11'	28°24'	1928	1932	5	16	26.7			
93	0632 678 W	A42E	GEELHOUTKOP	-24°18'	28°23'	1903	1914	12	21	14.6			
94	0632 726 W	A50B	TAFELKOP	-24° 6'	28°25'	1929	1979	51	24	3.9	X		X
95	0632 746 W	A42C	GLENTIG	-24°26'	28°26'	1922	1942	21	7	2.8		X	X
96	0632 797 W	A50A	NOOITGEDACHT	-24°18'	28°27'	1940	1964	25	11	3.7	X	X	X
97	0632 886 W	A50A	ELANDBOSCH	-24°15'	28°30'	1914	1940	27	38	11.7	X		X
98	0633 041 W	A50B	JONKMANSDRIFT	-24°11'	28°32'	1983	2008	26	22	7.1	X		X
99	0633 117 W	A61H	WELGEVONDEN	-24°28'	28°34'	1915	1918	4	9	18.8			
100	0633 180 W	A61D	RIETFONTEIN	-24°30'	28°35'	1924	1941	18	20	9.3			
101	0633 185 W	A61J	BACCHUS	-24° 5'	28°38'	1946	1983	38	15	3.3			
102	0633 237 W	A61D	RIETFONTEIN	-24°27'	28°38'	1904	1914	11	28	21.2			
103	0633 247 W	A61J	GROOTHOEK	-24° 6'	28°39'	1908	1914	7	24	28.6			
104	0633 374 W	A61J	KLIPSPRUIT	-24°15'	28°44'	1913	1952	40	11	2.3			
105	0633 393 W	A61J	ZAAIPLAATS	-24° 4'	28°42'	1915	1993	79	45	4.7	X		X
106	0633 400 D	A61J	A6E003 Sterk River @ Experimental Farm	-24°10'	28°44'	1968	1970	3	6	16.7			
107	0633 422 W	A61G	TINMYNE	-24° 2'	28°45'	1981	2008	28	13	3.9			
108	0633 429 W	A61J	STERKRIVIER - NEDERSETTI	-24° 9'	28°45'	1956	1978	23	19	6.9			
109	0633 445 W	A61E	DRIEFONTEIN	-24°25'	28°45'	1924	1945	22	28	10.6			
110	0633 450 W	A61D	GROOTVLEI	-24°30'	28°44'	1912	1963	52	84	13.5			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
111	0633 459 W	A61J	STERKRIVIER - NEDERSETTI	-24° 9'	28°46'	1978	2008	31	15	4			
112	0633 463 W	A61J	VASTRAP	-24°13'	28°46'	1926	1983	58	12	1.7	X		X
113	0633 467 D	A61H	A6E001 Doorndraai @ Doorndraai Dam	-24°17'	28°46'	1954	2008	55	35	5.3			
114	0633 478 W	A61D	TOBIASZYNLOOP	-24°28'	28°46'	1922	1948	27	35	10.8			
115	0633 482 W	A61G	GROENFONTEIN	-24° 3'	28°47'	1908	1952	45	57	10.6	X		X
116	0633 497 W	A61J	DOORNDRAAI	-24°16'	28°47'	1905	1954	50	50	8.3	X		X
117	0633 503 W	A61E	RIETFONTEIN	-24°23'	28°47'	1911	1968	58	104	14.9	X		X
118	0633 667 W	A61G	BLINKWATER	-24° 6'	28°53'	1933	1952	20	32	13.3			
119	0633 713 P	A61E	DROS P POTGIETERSRUS	-24°23'	28°54'	0	0	1	0	0			
120	0633 770 W	A61E	RONDEBOSCHJE	-24°19'	28°56'	1904	1958	55	47	7.1			
121	0633 796 W	A61F	MOORDDRIFT	-24°16'	28°58'	1918	1991	74	90	10.1	X		X
122	0633 796AW	A61F	MOORDDRIFT	-24°16'	28°57'	1984	2008	25	18	6			
123	0633 849 W	A61F	MAHWELERENG	-24° 9'	28°59'	1986	2008	23	35	12.7			
124	0633 852 W	A61F		-24°12'	28°59'	1992	1994	3	7	19.4			
125	0633 859 W	A61E	GRASSVALLEY	-24°19'	28°59'	1933	1943	11	45	34.1			
126	0633 881 W	A61F	POTGIETERSRUS - SKL	-24°11'	29° 0'	1903	1991	89	465	43.5			X
127	0633 881AW	A61F	POTGIETERSRUS - POL	-24°11'	29° 1'	1903	1996	94	42	3.7	X		
128	0633 882 W	A61F	POTGIETERSRUS E	-24°12'	29° 0'	1994	2008	15	31	17.2			
129	0633 887 W	A61F	ROOIPOORT	-24°17'	29° 0'	1976	2004	29	13	3.7	X		
130	0633 895 W	A61E	BLINKWATER	-24°25'	29° 0'	1911	1915	5	6	10			
131	0634 011 A	A61F	POTGIETERSRUS.	-24°11'	29° 1'	1955	1971	17	12	5.9			
132	0634 011 D	A61F	A6E002 Potgietersrus	-24°11'	29° 1'	1956	1979	24	8	2.8			
133	0634 011 W	A61F	POTGIETERSRUS - TABAK KO	-24°11'	29° 1'	1956	1991	36	30	6.9	X		X
134	0634 036 W	A61F	UITLOOP	-24° 6'	29° 2'	1911	1929	19	6	2.6			
135	0634 040 D	A61F	A6E007 Piet Potgietersrust @ Gert Combrink Dam	-24°10'	29° 2'	1982	1988	7	10	11.9			
136	0634 128 W	A61F	UITKYK	-24° 8'	29° 4'	1914	1952	39	36	7.7			
137	0634 131 W	A61F	PLANKNEK	-24°11'	29° 4'	1903	1985	83	52	5.2	X		X
138	0634 181 W	A61F	LUNSKLIP	-24° 1'	29° 8'	1952	1985	34	11	2.7	X		X

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				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
139	0634 332 W	A61F	INNERLEITHEN	-24° 2'	29°12'	1922	1927	6	14	19.4			
140	0634 362 W	A71A	ROTTERDAM	-24° 2'	29°14'	1932	1945	14	19	11.3			
141	0634 482 W	A71A	HOLLANDSDRIFT	-24° 1'	29°18'	1919	1922	4	13	27.1			
142	0634 513 W	A71A	EXCELSIOR	-24° 3'	29°18'	1922	1953	32	30	7.8			
143	0634 631 W	A71A	PIETERSBURG - KUSCHKE	-24° 1'	29°22'	1984	1987	4	17	35.4			
144	0634 633 W	A71A	WILDEBEESTFONTEIN	-24° 2'	29°21'	1912	1950	39	25	5.3			
145	0673 015 W	A41D	WILTON VALLEY	-23°45'	27° 1'	1918	1952	35	13	3.1	X		X
146	0673 081 W	A41D	IRELAND	-23°51'	27° 3'	1949	1977	29	14	4			
147	0673 128 W	A41E	KRUISPAD	-23°39'	27° 5'	1918	1974	57	49	7.2	X		X
148	0673 160 W	A41E	VAN JAARVELDPAN	-23°40'	27° 6'	1974	2003	30	16	4.4	X		X
149	0673 239 W	A41D	MATJIESFONTEIN	-23°58'	27° 9'	1961	2003	43	14	2.7	X		X
150	0673 284 W	A41E	HAAKDOORNPAN	-23°44'	27°10'	1952	1989	38	20	4.4	X		X
151	0673 411 W	A41D	MIMOSA PARK	-23°50'	27°12'	1958	1973	16	12	6.3			
152	0673 463 W	A41E	STEENBOKPAN	-23°43'	27°16'	1985	1986	2	20	83.3			
153	0673 627 W	A41C	DIEPSPRUIT	-23°57'	27°23'	1935	1940	6	2	2.8			
154	0673 636 W	A41E	TAMBOOTIEVLEI	-23°36'	27°21'	1957	2000	44	27	5.1	X	X	X
155	0673 645 W	A41E	ZYFERBULT	-23°45'	27°22'	1907	1951	45	57	10.6		X	X
156	0673 769 W	A42J	RIETFONTEIN	-23°50'	27°26'	1951	1965	15	14	7.8			
157	0674 025 W	A41C	VANDERLINDENSBULT	-23°55'	27°31'	1962	1977	16	10	5.2			
158	0674 045 W	A42J	GROOTVALLEI	-23°45'	27°32'	1944	1950	7	21	25			
159	0674 073 W	A42J	NAAUWONTKOMEN	-23°43'	27°34'	1950	1963	14	11	6.5			
160	0674 100 W	A42J	GROOTGELUK (MYN)	-23°40'	27°34'	1975	2008	34	22	5.4		X	X
161	0674 207 W	A42G	STERKFONTEIN	-23°57'	27°38'	1938	1998	61	18	2.5	X	X	X
162	0674 311 W	A42H	ELLISRAS	-23°41'	27°41'	1982	1992	11	15	11.4			
163	0674 319 W	A42G	FOURIESKLOOF	-23°50'	27°41'	1935	1952	18	24	11.1			
164	0674 321 W	A42G	AFGUNST	-23°50'	27°41'	1929	1936	8	34	35.4			
165	0674 333 W	A42J	SHOT BELT	-23°33'	27°43'	1910	1914	5	26	43.3			
166	0674 341 W	A42H	ELLISRAS E	-23°41'	27°42'	1992	2008	17	20	9.8			

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167	0674 388 D	A42G	A4E007 Mokolo Nat.Res @ Mokolo Dam	-23°58'	27°43'	1977	2007	31	24	6.5			
168	0674 400 W	A42H	ELLISRAS - POL	-23°41'	27°44'	1967	2008	42	11	2.2	X	X	X
169	0674 429 W	A42H	GROOTFONTEIN	-23°39'	27°45'	1933	1977	45	51	9.4	X		
170	0674 602 W	A42J	PENTON VILLA	-23°33'	27°50'	1934	1942	9	4	3.7			
171	0674 624 W	A42G	DOORNDRAAI	-23°55'	27°51'	1967	1972	6	20	27.8			
172	0674 817 W	A50F	ELLISRAS	-23°38'	27°58'	1978	1989	12	13	9			
173	0674 845 W	A50G	ROTTERDAM	-23°35'	28° 0'	1933	1953	21	58	23			
174	0674 855 W	A42H	DUIKERRIVIER	-23°45'	27°59'	1951	1989	39	26	5.6	X	X	X
175	0675 117 W	A42H	DERDEKRAAL	-23°57'	28° 5'	1919	1983	65	23	2.9	X	X	X
176	0675 125 W	A50G	AUTORITEIT	-23°35'	28° 5'	1931	1978	48	25	4.3	X	X	X
177	0675 182 W	A50G	VILLA NORA - POL	-23°32'	28° 7'	1908	2008	101	25	2.1	X	X	X
178	0675 247 D	A50F	A5E002 Hope Town @ Vischgat Dam	-23°37'	28° 9'	1969	1988	20	13	5.4			
179	0675 278 W	A50E	VISCHGAT	-23°38'	28°10'	1946	1953	8	13	13.5			
180	0675 454 W	A50G	WILLOWMORE	-23°34'	28°17'	1937	1953	17	23	11.3			
181	0675 547 W	A50E	GROBBELAARSHOEK	-23°37'	28°19'	1949	1981	33	15	3.8			
182	0675 666 W	A62D	MARKEN E	-23°36'	28°23'	1992	2008	17	21	10.3			
183	0675 686 W	A50D	KWARRIEHOEK	-23°56'	28°22'	1952	1952	1	8	66.7			
184	0675 695 W	A62D	MARKEN	-23°35'	28°24'	1936	1963	28	32	9.5			
185	0675 712 W	A50D	DAGGAKRAAL	-23°52'	28°26'	1959	2001	43	14	2.7	X		X
186	0675 720 W	A50B	MUISVOGELKRAAL	-24° 0'	28°24'	1931	1974	44	61	11.6			
187	0675 761 W	A62D	KOENAP	-23°41'	28°27'	1925	1955	31	20	5.4	X		X
188	0676 038 W	A62D	KLEIN GALAKWIN	-23°38'	28°32'	1923	1937	15	19	10.6			
189	0676 128 W	A62C	HAAKDOORNDRAAI	-23°37'	28°35'	1948	1989	42	14	2.8	X		X
190	0676 178 W	A62A	KLIPFONTEIN	-23°59'	28°36'	1938	1940	3	12	33.3			
191	0676 237 W	A62A	VERDOORNSDRAAI	-23°57'	28°38'	1940	2008	69	32	3.9	X		X
192	0676 293 W	A62B	EYSSELSDRIFT	-23°53'	28°41'	1948	1954	7	15	17.9			
193	0676 363 W	A62G	SALEM	-23°33'	28°43'	1948	1991	44	13	2.5			
194	0676 385 W	A62B	KLIPPLAATSDRIFT	-23°55'	28°43'	1931	1937	7	9	10.7			

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195	0676 417 W	A61J	TINMYNE - BELLEVUE	-23°57'	28°44'	1989	1989	1	8	66.7			
196	0676 473 W	A62B	BAKENBERG	-23°53'	28°46'	1985	2008	24	26	9			X
197	0676 498 W	A62B	GOOD HOPE	-23°48'	28°47'	1920	1930	11	16	12.1			
198	0676 523 W	A62F	VAALPENSKRAAL	-23°42'	28°49'	1954	2008	55	19	2.9	X		X
199	0676 530 W	A62B	MALOKONG	-23°50'	28°48'	1913	1919	7	9	10.7			
200	0676 557 W	A62F	ALAN'S HOPE	-23°47'	28°49'	1928	1929	2	5	20.8			
201	0676 597 W	A61G	ELANDSFONTEIN	-23°57'	28°50'	1986	1988	3	12	33.3			
202	0676 679 W	A62F	STIRUM	-23°49'	28°54'	1927	1952	26	22	7.1	X		X
203	0676 705 W	A62F	SWERWERSKRAAL	-23°45'	28°54'	1924	2001	78	21	2.2	X		X
204	0676 777 W	A61G	BLINKWATER	-23°57'	28°56'	1938	1939	2	9	37.5			
205	0676 783 W	A62E	CROMFORD	-23°33'	28°58'	1951	2008	58	36	5.2	X		X
206	0676 838 W	A61G	ARMOEDE	-23°58'	28°58'	1948	1974	27	18	5.6			
207	0676 839 W	A61G	ARMOEDE	-23°59'	28°58'	1948	1969	22	10	3.8			
208	0677 099 W	A62E	CHLOE	-23°38'	29° 4'	1948	2008	61	32	4.4	X		
209	0677 124 W	A62H	FAIRLIE	-23°34'	29° 5'	1948	1950	3	5	13.9			
210	0677 171 W	A62E	REXHAM	-23°51'	29° 6'	1921	1931	11	25	18.9			
211	0677 188 W	A62H	VULCANUS - HOSP	-23°38'	29° 7'	1929	1977	49	25	4.3		X	
212	0677 259 W	A62E	BERGZICHT	-23°49'	29° 8'	1920	2008	89	53	5	X		X
213	0677 350 P	A71E	DE MAECKER LPIETERSBURG	-23°50'	29°12'	0	0	1	0	0			
214	0677 440 W	A71F	JAKHALSFONTEIN	-23°51'	29°15'	1927	1957	31	21	5.6			
215	0677 456 W	A71E	ROODEPUT	-23°36'	29°16'	1954	2001	48	60	10.4	X		X
216	0677 470 W	A71F	NAAUWTE	-23°50'	29°16'	1903	1908	6	15	20.8			
217	0677 562 W	A71A	BIESJESPOL	-23°52'	29°20'	1911	1950	40	20	4.2	X		X
218	0677 601 W	A71E	KALKBANK	-23°32'	29°21'	1966	1971	6	9	12.5			
219	0677 720 P	A71A	SNYMAN PC PIETERSBURG	-24° 0'	29°24'	0	0	1	0	0			
220	0677 744 W	A71A	STERKLOOP	-23°54'	29°26'	1908	1918	11	10	7.6			
221	0677 764 W	A71A	PALMIETFONTEIN	-23°44'	29°26'	1922	1961	40	16	3.3			
222	0677 801 W	A71A		-23°51'	29°27'	1950	1951	2	2	8.3			

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223	0677 802 A	A71A	PIETERSBURG	-23°52'	29°27'	1950	1973	24	12	4.2			
224	0677 802 W	A71A	PIETERSBURG - WK	-23°52'	29°27'	1952	1991	40	97	20.2			
225	0677 802AW	A71A	PIETERSBURG - WK	-23°52'	29°27'	1985	1991	7	7	8.3			
226	0677 802BW	A71A	PIETERSBURG - WK	-23°52'	29°27'	1919	2008	90	11	1			
227	0677 805 W	A71A	ROSENEATH	-23°55'	29°27'	1911	1949	39	63	13.5			
228	0677 818 W	A71F	THORNELOE	-23°38'	29°29'	1912	1985	74	51	5.7			
229	0677 834 W	A71A	PIETERSBURG - HOSP	-23°54'	29°28'	1904	2008	105	71	5.6	X		X
230	0677 834AW	A71A	PIETERSBURG - POS	-23°54'	29°28'	1903	1914	12	20	13.9			
231	0677 834BW	A71A	PIETERSBURG - SKL	-23°55'	29°28'	1903	1937	35	30	7.1			
232	0677 862 D	A71A	A7E003 Pietersburg	-23°52'	29°27'	1956	2008	53	31	4.9			
233	0677 866 W	A71A		-23°56'	29°29'	1939	1950	12	12	8.3			
234	0677 891AW	A71A	TWEEFONTEIN	-23°51'	29°29'	1912	1935	24	27	9.4			
235	0677 897 W	A71A	WELTEVREDEN	-23°57'	29°30'	1905	1927	23	45	16.3			
236	0678 002 W	A71C	BYLSTEEL	-23°32'	29°31'	1932	1973	42	23	4.6			
237	0678 023 W	A71A	BROADLANDS	-23°53'	29°31'	1917	2008	92	39	3.5	X		X
238	0678 029 W	A71A	PALMIETFONTEIN	-24° 0'	29°31'	1980	1982	3	5	13.9			
239	0678 060 W	A71B	PALMIETFONTEIN	-24° 0'	29°34'	1922	1944	23	15	5.4			
240	0678 077 W	A71A	PAPKUIL	-23°47'	29°33'	1954	1955	2	5	20.8			
241	0678 082 W	A71A	BASKOPPIE	-23°52'	29°32'	1926	1943	18	39	18.1			
242	0678 102 W	A71A	FORT KLIPDAM	-23°42'	29°34'	1949	1951	3	9	25			
243	0678 132 W	A71C	SANDRIVIERSPOORT	-23°41'	29°36'	1928	1990	63	23	3	X		X
244	0678 132AW	A71A	KLIPDAM	-23°44'	29°34'	1906	1926	21	56	22.2			
245	0678 142 W	A71B	DE PUT	-23°53'	29°37'	1908	1919	12	60	41.7			
246	0678 144 W	A71B	KALKFONTEIN	-23°56'	29°35'	1905	2008	104	27	2.2	X		X
247	0678 215 W	A71C	WATERVAL	-23°35'	29°38'	1903	1939	37	15	3.4			
248	0678 217 W	A71C	PIETERSBURG - CORBADRAAI	-23°37'	29°38'	1986	1987	2	9	37.5			
249	0678 228 W	A71B	HAPPY VALLEY	-23°48'	29°38'	1933	1947	15	30	16.7			
250	0678 291 A	A71B	UNIV VAN NOORDE VB	-23°51'	29°40'	1984	1990	7	24	28.6			

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251	0678 297 W	A71B	MAJEBASKRAAL	-23°57'	29°39'	1916	1973	58	18	2.6			
252	0678 303 W	A71C	MAROELAPUT	-23°33'	29°42'	1923	1939	17	21	10.3			
253	0678 326 W	A71B	MAJEBASKRAAL	-23°56'	29°39'	1926	1949	24	29	10.1			
254	0678 381 W	A71B	SYFERKUIL	-23°52'	29°42'	1948	2008	61	25	3.4	X		X
255	0678 397 W	A71C	KALKFONTEIN	-23°37'	29°44'	1920	1924	5	16	26.7			
256	0678 402 W	A71C	DAMPLAATS	-23°41'	29°44'	1913	1944	32	24	6.3			
257	0678 580 W	A71C	KLEINBEGIN	-23°40'	29°50'	1914	1952	39	22	4.7			
258	0678 661 P	A71A	Dalmada	-23°53'	29°30'	1985	1999	15	9	5			
259	0678 680 W	A71B	KRATZENSTEIN	-23°50'	29°53'	1952	1998	47	25	4.4			
260	0678 696 W	A71C	WILGEBOSCHFONTEIN 11	-23°37'	29°54'	1938	1957	20	43	17.9			
261	0678 722 W	A71C	DRIEFONTEIN	-23°32'	29°55'	1926	1988	63	38	5	X		X
262	0678 725 W	A71C	WILGEBOSCHFONTEIN 1	-23°35'	29°55'	1903	1961	59	30	4.2			
263	0717 595 W	A41E	STOCKPOORT - POL	-23°24'	27°21'	1924	2007	84	36	3.6	X		X
264	0717 624 P	A41E	PARRS HALT	-23°24'	27°21'	1959	1988	30	204	56.7			
265	0717 834 W	A41E	DE DAM	-23°24'	27°27'	1926	1953	28	30	8.9			
266	0718 147 W	A41E	DEELKRAAL	-23°26'	27°35'	1957	1964	8	20	20.8			
267	0718 319 W	A42J	NEWLANDS	-23°19'	27°43'	1931	1934	4	12	25			
268	0718 327 W	A42J	ORANJEFONTEIN	-23°27'	27°41'	1908	1955	48	5	0.9		X	
269	0718 404 D	A42J	A4E003 Zandpan	-23°14'	27°44'	1962	1965	4	15	31.3			
270	0718 404 W	A42J	SANDPAN	-23°14'	27°44'	1961	1969	9	12	11.1			
271	0718 409 W	A42J	RUSTENBURG - NO 517	-23°19'	27°44'	1929	1977	49	25	4.3			
272	0718 434 W	A42J	SANDPAN	-23°14'	27°45'	1948	1965	18	20	9.3			
273	0718 491 W	A42J	SPECULATIE	-23°11'	27°47'	1948	1979	32	8	2.1		X	
274	0718 577 W	A50H	FIRST HOPE	-23° 7'	27°50'	1957	1966	10	18	15			
275	0718 647 W	A50H	ENKELVLEI	-23°17'	27°52'	1934	1970	37	12	2.7			
276	0718 674 W	A50H	ST HERTOGENBOSCH	-23°14'	27°54'	1971	1972	2	12	50			
277	0718 703 W	A50H	SELEKA	-23°13'	27°54'	1931	1933	3	13	36.1			
278	0718 736 W	A50H	MONGUE OF MOLINO	-23°16'	27°55'	1981	1987	7	9	10.7			

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279	0718 772 W	A50H	AFGUNST	-23°23'	27°57'	1948	1994	47	11	2	X	X	X
280	0718 781 W	A50H		-23° 1'	27°57'	2003	2003	1	10	83.3			
281	0718 798 W	A50H	WAGENKOP	-23°18'	27°58'	1952	1981	30	19	5.3			
282	0718 846 W	A50H	KLIPBANKFONTEIN	-23° 6'	27°59'	1944	1957	14	16	9.5			
283	0718 874 W	A50H	TOM BURKE	-23° 4'	28° 0'	1931	2008	78	42	4.5	X		X
284	0719 369 W	A50H	MARNITZ	-23° 9'	28°13'	1919	2001	83	11	1.1			
285	0719 370 A	A50H	MARNITZ.	-23°10'	28°13'	1943	1969	27	12	3.7			
286	0719 370 D	A50H	A5E001 Marnitz	-23°10'	28°13'	1956	1979	24	22	7.6			
287	0719 370 W	A50H	MARNITZ	-23°10'	28°13'	1943	1982	40	41	8.5			
288	0719 428 W	A50J	STRYDPAN	-23° 8'	28°15'	1937	1977	41	20	4.1			
289	0719 467 W	A50H	BOEKENHOUTFONTEIN	-23°17'	28°16'	1935	1965	31	22	5.9	X		X
290	0719 646 W	A63A	CAROLINA	-23°16'	28°23'	1951	1976	26	16	5.1			
291	0719 777 W	A62J	BUFFELSFONTEIN	-23°27'	28°26'	1956	1977	22	16	6.1			
292	0719 812 W	A63A	GROOTVLEI	-23° 2'	28°31'	1936	1938	3	6	16.7			
293	0720 069 W	A63A	TOLWE	-23° 9'	28°33'	1982	1983	2	20	83.3			
294	0720 085 W	A62J	ELANDSBOSCH	-23°25'	28°34'	1936	1944	9	14	13			
295	0720 110 W	A62J	REXFORD	-23°20'	28°34'	1927	1937	11	41	31.1			
296	0720 121 W	A63A	WELGEDACHT - SKL	-23° 1'	28°35'	1945	1975	31	26	7			
297	0720 164 W	A63A	WONDERKOP - NAT RES	-23°14'	28°36'	1919	2001	83	13	1.3			
298	0720 171 W	A62J	ROOIKOP	-23°21'	28°36'	1970	1971	2	13	54.2			
299	0720 181 W	A63A	WELTEVREDEN	-23° 1'	28°37'	1936	1951	16	14	7.3			
300	0720 198 W	A62J	OATLANDS	-23°17'	28°37'	1945	1970	26	10	3.2			
301	0720 202 W	A62J	DE DRAAI	-23°22'	28°36'	1972	1974	3	13	36.1			
302	0720 231 W	A62J	DE DRAAI	-23°22'	28°38'	1923	1927	5	12	20			
303	0720 271 W	A63A	DEADBEAT	-23° 2'	28°41'	1943	1944	2	3	12.5			
304	0720 280 W	A63A	STERKLOOP	-23°10'	28°39'	1942	1950	9	15	13.9			
305	0720 342 D	A62J	A6E004 Glen Alpine @ Glen Alpine Dam	-23°12'	28°42'	1967	2007	41	19	3.9			
306	0720 521 W	A63A	NORMANDY	-23°11'	28°48'	1912	1942	31	25	6.7	X		X

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
307	0720 634 W	A63A	BLOUBERG	-23° 4'	28°52'	1986	1994	9	19	17.6			
308	0720 727 W	A72A	LEIPZIG	-23° 7'	28°55'	1914	1977	64	55	7.2	X		X
309	0720 846 W	A72A	BLAAUWBERG	-23° 8'	29° 0'	1904	1927	24	9	3.1			
310	0721 157 W	A72A	INNES	-23° 7'	29° 6'	1945	1974	30	27	7.5			
311	0721 197 W	A72A	BOCHUM - 1	-23°17'	29° 7'	1919	1976	58	10	1.4	X		X
312	0721 257 W	A72A	BOCHUM	-23°17'	29° 8'	1927	2002	76	48	5.3	X		X
313	0721 304 W	A72A	TER SCHELLINGEN	-23° 5'	29°11'	1974	1990	17	20	9.8			
314	0721 363 W	A72A	SANDOWN	-23° 3'	29°13'	1927	1952	26	22	7.1			
315	0721 412 D	A71G	A7E007 Combro	-23°22'	29°14'	1968	1979	12	11	7.6			
316	0721 508 W	A71E	SOHO	-23°28'	29°17'	1922	1946	25	24	8			
317	0721 522 W	A71G	RED HILL	-23°12'	29°19'	1926	1964	39	17	3.6			
318	0721 562 W	A71E		-23°22'	29°19'	2001	2008	8	10	10.4			
319	0721 592 W	A71E	DENDRON - POL	-23°22'	29°20'	1970	2000	31	11	3	X		X
320	0721 618 W	A71G	WALDBURG	-23°18'	29°22'	1919	1985	67	29	3.6	X		X
321	0721 665 W	A71G	MARA - POL	-23° 5'	29°24'	1946	2008	63	21	2.8	X		X
322	0721 711 W	A71G	JAN ANTONIE	-23°21'	29°24'	1965	1984	20	10	4.2			
323	0721 725 W	A71G	MARA	-23° 5'	29°24'	1908	1945	38	21	4.6	X		X
324	0721 772 W	A71G	KALKFONTEIN	-23°22'	29°26'	1910	1964	55	22	3.3	X		X
325	0721 785 W	A71G	KILGOBBIN	-23° 5'	29°27'	1928	1936	9	14	13			
326	0721 846 W	A71G	GOEDGEDACHT	-23° 6'	29°29'	1937	1977	41	59	12			
327	0721 846AW	A71G	GOEDGEDACHT	-23° 5'	29°30'	1937	1945	9	23	21.3			
328	0721 849 W	A71G	HOUTRIVIER	-23°10'	29°29'	1934	1956	23	30	10.9			
329	0722 014 W	A71G	BOUW	-23°15'	29°30'	1924	1948	25	20	6.7			
330	0722 034 W	A71G	DALEMAIN	-23° 4'	29°33'	1930	1936	7	3	3.6			
331	0722 082 W	A71D	LEGKRAAL	-23°22'	29°34'	1922	2008	87	38	3.6	X		X
332	0722 099 A	A71D	MARA-AGR. 722/99	-23° 9'	29°34'	1936	1988	53	108	17			
333	0722 099 D	A71D	A7E005 Waerkum @ Mara	-23° 9'	29°34'	1958	1979	22	11	4.2			
334	0722 099 W	A71D	MARA - AGR	-23° 9'	29°34'	1919	2008	90	35	3.2	X		X

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				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
335	0722 122 W	A71H	BUFFELSPOORT	-23° 2'	29°35'	1926	1943	18	17	7.9			
336	0722 123 W	A71D	ZAMENKOMST	-23° 4'	29°35'	1923	1929	7	9	10.7			
337	0722 207 W	A71C	TARENDAALDRAAI	-23°28'	29°38'	1960	1974	15	7	3.9			
338	0722 208 W	A71C	KLAARWATER	-23°28'	29°36'	1910	1918	9	17	15.7			
339	0722 267 W	A71C	DE ONDERSTEWAGENDRIFT	-23°28'	29°39'	1949	1960	12	9	6.3			
340	0722 277 W	A71H	UNA - AGR	-23° 7'	29°40'	1919	2008	90	17	1.6	X		X
341	0722 301 W	A71H	CAPESTHORNE	-23° 2'	29°42'	1924	1967	44	30	5.7			
342	0722 308 W	A71H	MAY	-23° 8'	29°42'	1936	1938	3	6	16.7			
343	0722 314 W	A71D	RONDEHOEK	-23°14'	29°41'	1924	1934	11	17	12.9			
344	0722 391 W	A71H	HAPPY REST	-23° 1'	29°44'	1922	1951	30	19	5.3	X		X
345	0722 409 W	A71D	BULTFONTEIN	-23°18'	29°44'	1916	1961	46	38	6.9			
346	0722 413 W	A71C	HAAKDOORN	-23°24'	29°45'	1933	1936	4	20	41.7			
347	0722 417 W	A71C	MATOKS	-23°26'	29°43'	1975	1997	23	9	3.3			
348	0722 447 W	A71C	DWARSRIVIER	-23°29'	29°44'	1903	1931	29	43	12.4			
349	0722 481 W	A71H	HILLSIDE	-23° 1'	29°48'	1910	1911	2	11	45.8			
350	0722 491 W	A71H	MASHABA	-23°11'	29°47'	1914	1952	39	29	6.2			
351	0722 493 W	A71H	TWEEPUTKOPPIES	-23°13'	29°47'	1938	1947	10	16	13.3			
352	0722 496 W	A71H	SILVERBANK	-23°16'	29°47'	1923	1931	9	9	8.3			
353	0722 497 W	A71D	ROUWPUT	-23°18'	29°47'	1926	1977	52	6	1			
354	0722 509 W	A71C	RAMOKGOPA	-23°28'	29°49'	1950	1996	47	31	5.5			
355	0722 529 W	A71D	BANDELIERKOP - POL	-23°19'	29°48'	1905	2008	104	112	9			
356	0722 571 W	A71H	VERSAMELHOEK	-23° 2'	29°50'	1907	1988	82	32	3.3	X		X
357	0722 593 W	A71C	ZYFERGAT	-23°23'	29°49'	1917	1955	39	18	3.8			
358	0722 653 W	A71C	BULTFONTEIN	-23°24'	29°52'	1911	1965	55	12	1.8			
359	0722 660 W	A71C	DE WINDAM	-23°30'	29°52'	1922	1941	20	21	8.8			
360	0722 692 W	A71H	STONEHENGE	-23° 2'	29°54'	1904	1921	18	20	9.3			
361	0722 693 A	A71H	LOUIS TRICHARDT 722/	-23° 3'	29°54'	1905	1977	73	624	71.2			
362	0722 693 D	A71H	A7E004 Louis Trichardt @ Louis Trichardt dam	-23° 3'	29°54'	1956	1980	25	70	23.3			

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				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
363	0722 693 W	A71H	LOUIS TRICHARDT	-23° 2'	29°54'	1903	1991	89	103	9.6			
364	0722 693AW	A71H	LOUIS TRICHARDT	-23° 3'	29°54'	1984	2008	25	16	5.3			
365	0722 721 W	A71H	WATER RESERWE - BOS	-23° 1'	29°55'	1912	2008	97	24	2.1	X		X
366	0722 749 W	A71C	HASEBULT	-23°28'	29°53'	1923	1986	64	49	6.4			
367	0722 779 W	A71C	SOEKMEKAAR - POL	-23°30'	29°56'	1964	2008	45	22	4.1			
368	0761 810 W	A50H	GROBLERSBRUG - POL	-23° 0'	27°57'	1965	2000	36	2	0.5	X		X
369	0762 228 W	A50J	ZWARTBERG	-22°48'	28° 8'	1911	1917	7	20	23.8			
370	0762 372 W	A63C	ESSEXVALE	-22°42'	28°13'	1919	1962	44	16	3			
371	0762 401 W	A63C	TATIE	-22°40'	28°13'	1952	1977	26	10	3.2			
372	0762 488 W	A63C	DU PLESSIS	-22°38'	28°17'	1980	1991	12	12	8.3			
373	0762 507 W	A50J	OATLANDS	-22°59'	28°16'	1941	1967	27	21	6.5			
374	0762 532 W	A50J	DROEVLEI	-22°52'	28°18'	1936	1985	50	11	1.8	X		X
375	0762 795 W	A63C	MAASTROOM - POL	-22°45'	28°27'	1929	1962	34	12	2.9	X		X
376	0762 807 W	A63A	RONDEBOSCH	-22°59'	28°27'	1948	1955	8	11	11.5			
377	0763 046 W	A63C	ELANDSHOEK	-22°46'	28°32'	1991	2002	12	9	6.3			
378	0763 095 W	A63C	SWANEPOELSDRIF	-22°34'	28°34'	1936	1971	36	47	10.9			
379	0763 124 W	A63C	SAAMBOUBRUG - POL	-22°34'	28°35'	1963	2008	46	12	2.2	X		X
380	0763 149 W	A63A	TOLWE - POL	-22°59'	28°35'	1969	2008	40	12	2.5	X		X
381	0763 154 W	A63C	TUGELA	-22°34'	28°37'	1927	1929	3	9	25			
382	0763 264 W	A63B	EENDRACHT	-22°54'	28°40'	1925	1932	8	15	15.6			
383	0763 313 W	A63B	GROENDRAAI	-22°43'	28°42'	1949	1978	30	14	3.9			
384	0763 332 P	A63C	BAINES DRIFT	-22°32'	28°42'	1960	1988	29	48	13.8			
385	0763 362 P	A63C	SAAMBOU	-22°32'	28°43'	1980	1985	6	24	33.3			
386	0763 434 W	A63B	CANTERBURY	-22°44'	28°45'	1925	1926	2	12	50			
387	0763 675 W	A63D	DE GRACHT	-22°49'	28°54'	1933	1972	40	13	2.7	X		
388	0763 743 W	A63D	STOLZENFELS	-22°55'	28°54'	1948	2004	57	37	5.4	X		X
389	0764 056 W	A63D	KROMHOEK	-22°56'	29° 2'	1964	1974	11	19	14.4			
390	0764 061 W	A63E	CONCORDIA	-22°30'	29° 3'	1953	1955	3	15	41.7			

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				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
391	0764 114 W	A63D	ALFRED	-22°55'	29° 3'	1944	1978	35	17	4			
392	0764 161 W	A63D	ALLDAYS - POL	-22°41'	29° 6'	1930	1992	63	20	2.6	X		X
393	0764 161AW	A63D	ALLDAYS	-22°41'	29° 6'	1956	1958	3	24	66.7			
394	0764 161BW	A63D	ALLDAYS E	-22°41'	29° 6'	1991	2003	13	25	16			
395	0764 187 W	A63E	PALMERSTON	-22°38'	29° 7'	1923	1935	13	5	3.2			
396	0764 321 W	A72B	PIETERSDAAL	-22°52'	29°11'	1979	1980	2	8	33.3			
397	0764 334 W	A63E	COVENTRY	-22°34'	29°13'	1954	1959	6	2	2.8			
398	0764 367 W	A63E	POLTON	-22°38'	29°13'	1960	1969	10	11	9.2			
399	0764 385 W	A72B	CARLOW	-22°54'	29°13'	1938	1961	24	16	5.6			
400	0764 414 W	A72B	WINTERSVELD	-22°54'	29°14'	1962	1978	17	7	3.4			
401	0764 491 W	A72B	GORDON	-22°41'	29°17'	1929	1941	13	40	25.6			
402	0764 597 W	A71J		-22°57'	29°20'	1948	1953	6	15	20.8			
403	0764 692 W	A63E	DALMUIR	-22°32'	29°24'	1938	1958	21	17	6.7			
404	0764 710 W	A72B	OMLOOP	-22°50'	29°25'	1937	1978	42	19	3.8	X		X
405	0764 738 W	A72B	TAMWORTH	-22°48'	29°25'	1934	1938	5	27	45			
406	0764 782 W	A72B	DIRLETON	-22°33'	29°27'	1959	1968	10	5	4.2			
407	0764 856 W	A71J		-22°46'	29°29'	1939	1942	4	10	20.8			
408	0764 880 W	A72B	WATERPOORT - BRENHILDE	-22°40'	29°30'	1984	1993	10	8	6.7			
409	0764 899 W	A71H	VENTERSDORP	-23° 0'	29°30'	1933	1953	21	11	4.4			
410	0765 007 W	A72B	BANDUR	-22°37'	29°32'	1925	1964	40	13	2.7	X		X
411	0765 010 W	A72B	BANDUR	-22°40'	29°31'	1984	1985	2	10	41.7			
412	0765 015 W	A71J		-22°45'	29°31'	1956	1957	2	17	70.8			
413	0765 083 W	A71J	ALBERT	-22°53'	29°33'	1941	1960	20	16	6.7			
414	0765 144 W	A71J	STERKSTROOM	-22°54'	29°35'	1923	1940	18	30	13.9			
415	0765 229 W	A71J	JAGKRAAL	-22°49'	29°38'	1956	1966	11	23	17.4			
416	0765 230 W	A71J	KOEDOESVELD	-22°50'	29°38'	1966	1977	12	10	6.9			
417	0765 232 W	A71J	SUTHERLAND	-22°52'	29°38'	1921	1929	9	14	13			
418	0765 234 W	A71J	WATERPOORT - POL	-22°54'	29°38'	1969	1991	23	55	19.9			

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419	0765 234AW	A71J	WATERPOORT - POL	-22°54'	29°38'	1977	2008	32	13	3.4			
420	0765 253 W	A71J	SANDOW	-22°43'	29°39'	1962	1987	26	7	2.2	X		X
421	0765 295 W	A71J	BERGWATER	-22°54'	29°40'	1966	1967	2	6	25			
422	0765 323 W	A71J	ROCHDALE	-22°53'	29°41'	1968	1988	21	3	1.2			
423	0765 354 W	A71J	ROCHDALE	-22°53'	29°42'	1968	1985	18	8	3.7			
424	0765 382 W	A71J	WOODLANDS	-22°53'	29°43'	1923	1926	4	16	33.3			
425	0765 384 W	A71J	BLACKSTONE	-22°53'	29°43'	1961	1966	6	9	12.5			
426	0765 455 W	A71K	KEMPSHALL	-22°35'	29°46'	1926	1951	26	25	8	X		X
427	0765 599 W	A80D	ALASKA	-22°59'	29°50'	1929	1952	24	123	42.7			
428	0765 607 W	A71K	MOPANE - SKL	-22°37'	29°51'	1951	1991	41	79	16.1	X		X
429	0765 607AW	A71K	MOPANE - SKL	-22°37'	29°51'	1977	1992	16	17	8.9			
430	0765 609 W	A71K	VANDERBYL	-22°38'	29°51'	1925	1935	11	32	24.2			
431	0765 621 W	A80E	KALKBULT	-22°52'	29°52'	1919	1932	14	17	10.1			
432	0765 667 W	A71K	DREYER	-22°37'	29°53'	1992	2000	9	6	5.6			
433	0765 682 W	A80E	MASEQUA	-22°52'	29°53'	1933	1952	20	11	4.6			
434	0765 689 W	A80E	LORANGE	-22°59'	29°53'	1908	1940	33	49	12.4			
435	0765 690 W	A71H	HANGLIP - BOS	-23° 0'	29°53'	1989	1998	10	9	7.5			
436	0765 697 W	A71K	DREYER	-22°37'	29°53'	1949	1982	34	17	4.2			
437	0765 707 W	A80F	DREYER	-22°47'	29°54'	1921	1985	65	18	2.3			
438	0765 708 W	A80F	MUTAMBA RANCH	-22°48'	29°54'	1921	2002	82	32	3.3	X		
439	0765 745 W	A80E	MARIUS	-22°55'	29°55'	1988	1999	12	11	7.6			
440	0765 749 W	A80E	SCHYFFONTEIN	-22°59'	29°55'	1964	1985	22	10	3.8			
441	0765 758 W	A71K		-22°38'	29°56'	2000	2004	5	13	21.7			
442	0765 776 W	A80E	FRANSHOEK	-22°56'	29°56'	1923	1926	4	18	37.5			
443	0765 779 D	A80E	A7E002 Gloudend @ Mountain Inn	-22°59'	29°56'	1956	1957	2	17	70.8			
444	0765 825 W	A80F	PHANTOM	-22°44'	29°59'	1926	1963	38	23	5	X		X
445	0765 885 W	A80F	MARTHA	-22°45'	29°59'	0	0	1	0	0			
446	0766 133 D	A80F	A8E001 Nairobi @ Nzhelele Dam	-22°43'	30° 5'	1946	2008	63	298	39.4			

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447	0766 133 W	A80F	KRANTZPOORT	-22°42'	30° 4'	1932	1955	24	15	5.2	X		X
448	0766 190 W	A80F	MOUNT STUART	-22°40'	30° 6'	1922	1925	4	16	33.3			
449	0766 201 W	A80B	MPHEFU	-22°54'	30° 7'	1965	2008	44	36	6.8	X		X
450	0766 202 A	A80B	VENDA RABALI	-22°52'	30° 7'	1986	1988	3	12	33.3			
451	0766 247 W	A80G	TSIPISE - ALICEDALE	-22°37'	30° 9'	1983	1984	2	14	58.3			
452	0766 248 W	A80G	ALICEDALE	-22°38'	30° 9'	1938	1945	8	36	37.5			
453	0766 269 W	A80A	JOUBERTSTROOM PLANTATION	-22°59'	30° 9'	1985	2008	24	18	6.3	X		X
454	0766 276 W	A80G	TSHIPISE	-22°36'	30°10'	1959	2008	50	11	1.8			X
455	0766 277 W	A80G	TSHIPISE	-22°37'	30°10'	1959	2006	48	115	20			
456	0766 324 W	A80A	SILOAM - HOSP	-22°54'	30°12'	1931	1990	60	18	2.5	X		X
457	0766 327 W	A80A	MPSEMA IRRIGATION SCHEME	-22°57'	30°11'	1965	1979	15	16	8.9			
458	0766 421 W	A80G	MPSEMA IRRIGATION SCHEME	-22°30'	30°15'	1957	1985	29	13	3.7			
459	0766 462 W	A80C	GARSIDE	-22°47'	30°17'	1965	1994	30	37	10.3	X		X
460	0766 563 W	A80A	TATE - BOS	-22°54'	30°18'	1963	1999	37	7	1.6			
461	0766 842 W	A80J	FOLONHODWE	-22°32'	30°29'	1954	2008	55	13	2	X		X
462	0807 598 W	A63C	PLATJAN-GRENSPOS	-22°28'	28°50'	1982	2008	27	14	4.3			X
463	0807 599 P	A63C	PLATJAAN	-22°29'	28°50'	1980	1988	9	28	25.9			
464	0808 056 W	A63E	STEMBOK	-22°26'	29° 2'	1926	1934	9	22	20.4			
465	0808 104 W	A63E	RATHO	-22°14'	29° 2'	1948	1956	9	10	9.3			
466	0808 139 W	A63E	VERGENOEGD	-22°20'	29° 5'	1954	1974	21	8	3.2			
467	0808 193 W	A63E	PARMA	-22°13'	29° 7'	1956	1964	9	16	14.8			
468	0808 207 W	A63E	WILLIAM PORTER	-22°27'	29° 7'	1944	1945	2	1	4.2			
469	0808 253 W	A63E	PONTDRIFT - POL	-22°13'	29° 8'	1965	2008	44	11	2.1	X		X
470	0808 317 W	A63E	BALERNO	-22°17'	29°11'	1936	1953	18	9	4.2			
471	0808 341 A	A63E	TUSCANEN.	-22°11'	29°12'	1965	1971	7	12	14.3			
472	0808 341 W	A63E	TUSCANEN	-22°11'	29°12'	1965	1981	17	7	3.4			
473	0808 373 P	A63E	LENTSWELEMORITI	-22°13'	29°13'	1981	1987	7	16	19			
474	0808 373 W	A63E	TUSCANEN	-22°12'	29°12'	1931	1936	6	12	16.7			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
475	0808 386 W	A63E	ICON	-22°25'	29°13'	1933	1952	20	14	5.8			
476	0808 390 W	A63E	BRIDGEWATER	-22°30'	29°13'	1943	1965	23	18	6.5			
477	0808 433 W	A63E	LODEWYKSVLEI	-22°13'	29°15'	1904	1936	33	18	4.5			
478	0808 764 W	A71L	NEKEL	-22°14'	29°26'	1968	1989	22	18	6.8	X		X
479	0809 285 W	A71L	GOEREE	-22°15'	29°40'	1936	1966	31	23	6.2	X		X
480	0809 327 W	A71K	KLEIN EDEN	-22°28'	29°40'	1948	1950	3	2	5.6			
481	0809 706 A	A71L	MESSINA AGRIC RES	-22°16'	29°54'	1930	1990	61	120	16.4	X		
482	0809 706 D	A71L	A7E006 Macuville	-22°16'	29°54'	1959	2003	45	21	3.9			
483	0809 706 W	A71L	MACUVILLE - AGR	-22°16'	29°54'	1919	2008	90	39	3.6			X
484	0809 734 A	A71L	MESSINA EXPERIMENTAL FARM	-22°14'	29°55'	1985	1990	6	24	33.3			
485	0810 056 W	A71K	PANGBOURNE	-22°25'	30° 1'	1923	1936	14	10	6			
486	0810 080 D	A71K	A7E001 Messina	-22°20'	30° 3'	1956	1964	9	11	10.2			
487	0810 080 W	A71K	MESSINA	-22°20'	30° 3'	1906	1954	49	54	9.2			
488	0810 080AW	A71K	MESSINA	-22°20'	30° 3'	1954	1963	10	56	46.7			
489	0810 081 W	A71K	MESSINA - POL	-22°21'	30° 3'	1965	2008	44	15	2.8	X		X
490	0810 081AW	A71K	MESSINA	-22°21'	30° 3'	1963	1965	3	12	33.3			
491	0810 358 W	A80G	HOOGEVELD	-22°27'	30°12'	1940	1954	15	15	8.3			
492	0810 390 W	A80G	DOREEN	-22°31'	30°13'	1931	1939	9	15	13.9			
493	0810 450 W	A80G	JOAN	-22°30'	30°15'	1957	1985	29	12	3.4			
494	0811 055 W	A80J	ADELAIDE	-22°25'	30°33'	1921	1944	24	19	6.6	X		X
495	0811 114 W	A80J	FESKRAAL	-22°24'	30°34'	1978	1979	2	10	41.7			
496	0811 172 W	A80J	BALI	-22°23'	30°34'	1961	1977	17	16	7.8			

Table A.2: List of rainfall stations near the Limpopo WMA North

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
1	0588 230 W	A24H	STERKFORTEIN	-24°50'	27°38'	1933	2003	71	27	3.2			
2	0588 307 W	A24H	SANDSPRUIT	-24°36'	27°40'	1917	1919	3	17	47.2			
3	0588 374 W	A24H	ONVERWACHT	-24°44'	27°42'	1913	1934	22	35	13.3			
4	0588 394 W	A24G	BUFFELSKLOOF	-24°33'	27°45'	1909	1916	8	15	15.6			
5	0588 406 W	A24H	ROOIBERG	-24°46'	27°44'	1907	2003	97	19	1.6			
6	0588 459 W	A24G	WELTEVREDE	-24°39'	27°46'	1949	1953	5	10	16.7			
7	0588 637 W	A24G	SANDFONTEIN	-24°37'	27°53'	1956	1987	32	14	3.6			
8	0588 732 W	A24G	KAREEFONTEIN	-24°42'	27°55'	1923	1950	28	59	17.6			
9	0588 768 W	A23H	MON DESIR	-24°48'	27°56'	1949	1952	4	7	14.6			
10	0589 088 W	A23H	NEWLANDS	-24°58'	28° 3'	1904	1927	24	34	11.8			
11	0589 110 W	A23H	MABALINGWE	-24°50'	28° 4'	1989	1990	2	11	45.8			
12	0589 116 W	A23H	SOETEINVAL	-24°57'	28° 4'	1971	1974	4	12	25			
13	0589 140 W	A23H	BOSCHPOORT	-24°50'	28° 3'	1938	1969	32	17	4.4			
14	0589 176 P	A23H	PRETORIUS JDH WARMBATHS	-24°56'	28° 6'	0	0	1	0	0			
15	0589 298 W	A23G	EENSGEVONDEN	-24°58'	28°10'	1911	1948	38	33	7.2			
16	0589 326 W	A23G	NOOITGEDACHT	-24°57'	28°10'	1911	1931	21	11	4.4			
17	0589 443 W	A23G	JOHANNA HOEVE	-24°53'	28°15'	1919	1930	12	46	31.9			
18	0589 472 W	A23G	WARMBAD - DAM	-24°52'	28°16'	1946	1953	8	8	8.3			
19	0589 476 W	A23G	NOODHULP	-24°56'	28°15'	1904	1948	45	44	8.1			
20	0589 476AW	A23G	NOODHULP	-24°56'	28°16'	1903	1947	45	50	9.3			
21	0589 503 W	A23G	WARMBAD - HOTEL	-24°53'	28°17'	1912	1991	80	796	82.9			
22	0589 503AW	A23G	WARMBAD - BADPLAAS	-24°53'	28°17'	1939	2002	64	25	3.3			
23	0589 503CW	A23G	WARMBAD- EKSP STASIE	-24°53'	28°17'	1909	1918	10	14	11.7			
24	0589 594 A	A23G	TOWOOMBA-NAVORSINGST	-24°54'	28°20'	1936	1990	55	120	18.2			
25	0589 594 W	A23G	WARMBAD - TOWOOMBA - AGR	-24°54'	28°20'	1936	2008	73	25	2.9			
26	0589 624 W	A23G	THORNEYCROFT	-24°54'	28°21'	1912	1926	15	49	27.2			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
27	0589 628 W	A23G	ROODEKUIL	-24°58'	28°21'	1907	1978	72	22	2.5			
28	0589 713 W	B31E	ZANDFONTEIN	-24°54'	28°24'	1906	1936	31	12	3.2			
29	0589 780 W	B31E	LEE UWKUIL	-25° 0'	28°25'	1919	1953	35	20	4.8			
30	0589 835 W	B31E	FOLKSTONE	-24°55'	28°30'	1928	1952	25	27	9			
31	0589 867 W	B31E	LUDLOW	-24°57'	28°28'	1903	2005	103	126	10.2			
32	0589 891 W	B31E	LEE UWDOORNS	-24°50'	28°29'	1930	1946	17	5	2.5			
33	0589 896 W	B31E	MALLOW	-24°56'	28°30'	1913	1972	60	18	2.5			
34	0589 897 W	B31E	DANDALOO	-24°58'	28°30'	1922	1972	51	12	2			
35	0590 028 W	B31E	ILLAWARRA	-24°59'	28°31'	1906	2008	103	62	5			
36	0590 055 W	B31E	GOOD HOPE	-24°54'	28°31'	1910	1960	51	40	6.5			
37	0590 056 W	B31E	KNAPBROOKE	-24°57'	28°31'	1907	1962	56	43	6.4			
38	0590 057 A	B31E	SETTLERS LHS	-24°57'	28°32'	1979	1981	3	12	33.3			
39	0590 057 W	B31E	SETTLERS	-24°57'	28°32'	1903	1950	48	36	6.3			
40	0590 087 A	B31E	SETTLERS 5	-24°57'	28°33'	1979	1990	12	24	16.7			
41	0590 171 W	B31E	WINBURG	-24°53'	28°37'	1912	1963	52	68	10.9			
42	0590 294 W	B31E	MEISJESVLEI	-24°53'	28°40'	1936	1977	42	14	2.8			
43	0590 321 W	B31E	KOPPIE ALLEEN	-24°51'	28°41'	1912	1974	63	87	11.5			
44	0590 322 W	B31E	DEERCROFT	-24°52'	28°42'	1915	1952	38	15	3.3			
45	0590 370 W	B51E	NYLSVLEY	-24°40'	28°43'	1974	1994	21	15	6			
46	0590 383 W	B31E	DE HOOP	-24°53'	28°43'	1982	1987	6	16	22.2			
47	0590 413 W	B31J	DIEPSLOOT	-24°53'	28°44'	1938	1982	45	15	2.8			
48	0590 474 W	B31J	SUNNINGDALE	-24°54'	28°46'	1903	1929	27	6	1.9			
49	0590 496 W	B31J	RIEKERTSVRAAG	-24°46'	28°48'	1910	1930	21	29	11.5			
50	0590 500 W	B31J	BYSONDER	-24°50'	28°47'	1923	1997	75	36	4			
51	0590 550 A	B51E	AMSTERDAM-GRECY.	-24°40'	28°49'	1952	1965	14	12	7.1			
52	0590 550AW	B51E	AMSTERDAM - CRECY	-24°40'	28°50'	1951	1967	17	45	22.1			
53	0590 610 A	B51E	TURFPAN 590/610.	-24°40'	28°51'	1934	1948	15	12	6.7			
54	0590 610 W	B51E		-24°40'	28°51'	1939	1948	10	19	15.8			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
55	0590 624 W	B31J	KALKPAN	-24°55'	28°51'	1917	1922	6	12	16.7			
56	0590 676 W	B31J	GROOTFONTEIN	-24°46'	28°52'	1950	1954	5	5	8.3			
57	0590 732 W	B51E	LOCATIE	-24°42'	28°56'	1924	1945	22	38	14.4			
58	0590 741 W	B31J	BOSCHPLAATS	-24°52'	28°55'	1933	1959	27	15	4.6			
59	0590 813 W	B51E	VLAKLAAGTE	-24°33'	28°59'	1936	1956	21	14	5.6			
60	0590 859 W	B31J	JOURNEY'S END	-24°49'	28°59'	1951	1952	2	14	58.3			
61	0590 868 W	B31J	DOORNLAAGTE	-24°58'	28°59'	1919	1935	17	16	7.8			
62	0590 897 W	B31J	KEEROM	-24°57'	29° 0'	1915	1946	32	12	3.1			
63	0629 312 P	Y10B	OLIFANTSDRIFT	-24°12'	26°41'	1970	1988	19	12	5.3			
64	0629 702 W	A24J	INMALKAAR	-24°12'	26°54'	1925	1979	55	24	3.6			
65	0629 824 W	A24J	SCHWERIN	-24°15'	26°58'	1979	1980	2	10	41.7			
66	0630 078 W	A24J	PARYS	-24°18'	27° 3'	1937	1946	10	11	9.2			
67	0630 145 A	A24J	MAKOPPA VANWYKSKRAAL	-24°25'	27° 5'	1985	1987	3	12	33.3			
68	0630 383 W	A24J	AGEN	-24°24'	27°11'	1921	1967	47	40	7.1			
69	0630 408 W	A24J	BRIGHTWOOD	-24°18'	27°14'	1929	1941	13	7	4.5			
70	0631 359 W	A24H	HARTEBEESTFONTEIN	-24°30'	27°42'	1939	1955	17	16	7.8			
71	0633 870 W	B51E	DERDEKRAALPOORT	-24°30'	28°59'	1959	1962	4	12	25			
72	0634 030 W	B51E	MOOIGELEGEN	-24°29'	29° 1'	1924	1955	32	19	4.9			
73	0634 050 W	B51E	PALMER ESTATE	-24°21'	29° 2'	1923	2008	86	58	5.6			X
74	0634 084 W	B51E	KALKFONTEIN	-24°23'	29° 2'	1910	1980	71	30	3.5			
75	0634 140 W	B51E	DOORNFONTEIN	-24°20'	29° 5'	1925	2008	84	38	3.8			
76	0634 348 W	B51E	MODDERFONTEIN	-24°18'	29°10'	1923	1949	27	22	6.8			
77	0634 373 W	B51G	GROOTVLEI	-24°13'	29°13'	1937	1954	18	24	11.1			
78	0634 417 W	B51E	UITZICHT	-24°27'	29°14'	1922	1989	68	25	3.1			
79	0634 427 W	B51F	EERSTELING	-24° 7'	29°15'	1989	1995	7	10	11.9			
80	0634 439 W	B51G	UITKYK	-24°19'	29°15'	1922	1940	19	64	28.1			
81	0634 457 W	B51F	EERSTELING	-24° 7'	29°16'	1904	1922	19	24	10.5			
82	0634 468 A	B51G	ZEBEDIELA.	-24°18'	29°16'	1973	1990	18	24	11.1			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
83	0634 559 W	B51G	ZEBEDIELA ESTATES	-24°19'	29°19'	1903	1937	35	46	11			
84	0634 566 W	B51E	VOLOP	-24°26'	29°19'	1940	1987	48	18	3.1			
85	0634 579 W	B51F	GOOD HOPE	-24° 9'	29°21'	1908	1947	40	17	3.5			
86	0634 580 W	B51F	VRISGEWAAGD	-24°10'	29°19'	1952	2008	57	18	2.6			
87	0634 585 W	B51F	FRISCHGEWAAGD	-24°15'	29°20'	1925	1943	19	22	9.6			
88	0634 622 W	B51G	ZEBEDIELA	-24°20'	29°18'	1948	1990	43	20	3.9			
89	0634 649 W	B51G	GROOTHOEK	-24°19'	29°20'	1921	1938	18	22	10.2			
90	0678 654 W	B52H	DRIEKOPPIES	-23°54'	29°52'	1913	1934	22	16	6.1			
91	0678 709 W	B81A	WOODBUSH	-23°48'	29°59'	1903	1913	11	15	11.4			
92	0678 730 P	B82A	DE RYSSCHEN ILANGKLOOF	-23°40'	29°55'	0	0	1	0	0			
93	0678 763 W	B82A	DRIEFONTEIN	-23°43'	29°56'	1940	1943	4	43	89.6			
94	0678 776 W	B81A	HAENERTSBURG - POL	-23°56'	29°56'	1903	2008	106	39	3.1			
95	0678 805 W	B81A	WELTEVREDEN	-23°54'	29°57'	1923	1977	55	29	4.4			
96	0678 808 W	B81A	ALLENDAL	-23°58'	29°57'	1915	1927	13	49	31.4			
97	0678 836 W	B81A	GLENSHIEL	-23°56'	29°58'	1939	2003	65	32	4.1			
98	0678 837 W	B81A	DENBURY	-23°57'	29°58'	1929	1939	11	20	15.2			
99	0678 858 W	B81A	BROEDERSTROOM - BOS	-23°51'	29°58'	1914	2008	95	52	4.6			
100	0678 863 W	B81A	STAMPBLOK FONTEIN	-23°53'	29°59'	1986	2004	19	13	5.7			
101	0678 866 D	B81A	B8E001 Onverwacht @ Ebenezer Dam	-23°56'	29°59'	1959	2007	49	17	2.9			
102	0678 883 W	B82B	RAMATOELASKLOOF	-23°42'	30° 0'	1912	1964	53	26	4.1			
103	0678 890 A	B81B	WOODBUSH-I-BOS.	-23°50'	30° 0'	1920	1959	40	12	2.5			
104	0678 890 W	B81B	WOODBUSH - 1 - BOS	-23°49'	30° 1'	1904	1959	56	30	4.5			
105	0678 893 W	B81B	MAGOEBASKLOOF	-23°53'	30° 0'	1959	1970	12	10	6.9			
106	0679 009 A	B82A	GOEDGELEGEN	-23°38'	30° 0'	0	0	1	0	0			
107	0679 019 W	B81B	DE HOEK - BOS	-23°49'	30° 1'	1922	1995	74	28	3.2			
108	0679 036 W	B82A	ALTYD MOOI	-23°36'	30° 2'	1919	1945	27	20	6.2			
109	0679 086 W	B81B	LETABADRIFT	-23°56'	30° 3'	1958	2004	47	11	2			
110	0679 106 W	B81B	TZANEEN - GRENSHOEK(SAPE	-23°46'	30° 4'	1985	1997	13	20	12.8			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
111	0679 106AW	B81B		-23°46'	30° 4'	1997	2006	10	30	25			
112	0679 115 W	B81B	DIGGERS REST	-23°55'	30° 4'	1913	1952	40	33	6.9			
113	0679 135 A	B81B	BERGENDAL	-23°45'	30° 5'	1963	1983	21	60	23.8			
114	0679 135 W	B81B	BELVEDERE	-23°45'	30° 5'	1939	2008	70	36	4.3			
115	0679 136 W	B81B	GRENSHOEK	-23°47'	30° 4'	1943	1969	27	30	9.3			
116	0679 139 W	B81B	MIDDELKOP - BOS	-23°49'	30° 5'	1912	1986	75	34	3.8			
117	0679 140 W	B81B	TZANEEN - MIDDELKOP(SAPE	-23°50'	30° 5'	1985	1992	8	28	29.2			
118	0679 141 W	B81B	VERGELEGEN	-23°51'	30° 5'	1931	2008	78	31	3.3			
119	0679 156 W	B82B	MOOKETSI - SAR	-23°36'	30° 6'	1923	1978	56	55	8.2			
120	0679 164 W	B81B	WESTFALIA	-23°44'	30° 6'	1912	2008	97	31	2.7			
121	0679 166 W	B81B	REDLANDS	-23°46'	30° 6'	1919	1925	7	6	7.1			
122	0679 194 A	B81B	DUIWELSKLOOF TZANEEN	-23°44'	30° 7'	1985	2008	24	216	75			
123	0679 197 W	B81B	ZOMERKOMST - BOS	-23°47'	30° 8'	1922	2008	87	24	2.3			
124	0679 221 W	B81B	DUIWELSKLOOF - MUN	-23°42'	30° 8'	1905	1982	78	48	5.1			
125	0679 227 W	B81B	MERENSKY - SKL	-23°48'	30° 8'	1926	2008	83	30	3			
126	0679 228 W	B81B	KRABBEFONTEIN	-23°48'	30° 8'	1903	1915	13	14	9			
127	0679 245 W	B82B	BOEKENHOUTBULT	-23°35'	30° 9'	1935	1977	43	29	5.6			
128	0679 274 W	B82B	KOEDOESRIVIER	-23°34'	30°10'	1919	2003	85	4	0.4			
129	0679 284 W	B81B	QUANTOCK	-23°44'	30°10'	1979	2004	26	17	5.4			
130	0679 287 D	B81B	B8E003 Doornhoek @ Tzaneen Dam	-23°47'	30°10'	1969	2004	36	13	3			
131	0679 315 W	B81B	GRASKRAAL	-23°46'	30°11'	1958	1979	22	13	4.9			
132	0679 316 W	B81B	MOEDERSFONTEIN	-23°46'	30°11'	1925	1938	14	29	17.3			
133	0679 372 P	B81B	GRANT DH DUIWELSKLOOF	-23°42'	30°13'	0	0	1	0	0			
134	0679 373 W	B81B	DRIEKOP	-23°44'	30°13'	1927	1928	2	10	41.7			
135	0679 401 W	B81B	TRIANGLE	-23°41'	30°14'	1917	1977	61	31	4.2			
136	0722 614 W	A91B	ZWARTRANDJES	-23°14'	29°52'	1920	2008	89	22	2.1			X
137	0722 616 W	A91B	NATKRUIT	-23°16'	29°51'	1934	1936	3	3	8.3			
138	0722 675 W	B82E	VLIEGENPAN	-23°16'	29°52'	1937	1974	38	15	3.3			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
139	0722 700 W	A91B	MAMPAKUIL	-23°10'	29°54'	1923	1992	70	34	4			X
140	0722 755 W	A91A	CLEARWATER	-23° 5'	29°56'	1911	1914	4	7	14.6			
141	0722 757 W	A91B	VYGEBOOMSPRUIT	-23° 8'	29°58'	1932	1953	22	20	7.6			
142	0722 781 W	A91A	MOW COP	-23° 1'	29°57'	1905	1917	13	32	20.5			
143	0722 783 W	A91A	LONZUEVAL	-23° 3'	29°57'	1923	1955	33	24	6.1			
144	0722 797 W	B82E	KOEDOESPOORT	-23°17'	29°57'	1927	1936	10	10	8.3			
145	0722 820 W	A91B	LOVEDALE PARK	-23°10'	29°58'	1910	1915	6	14	19.4			
146	0722 822 W	A91B	EAST LYNNE	-23°12'	29°58'	1909	1937	29	26	7.5			
147	0722 900 W	B82A	SPELONKEN - BOS	-23°30'	30° 0'	1933	2008	76	19	2.1			
148	0723 011 W	A91B	MODDERVLEI	-23°11'	30° 1'	1912	1914	3	7	19.4			
149	0723 031 W	A91A	ROODEWAL - BOS	-23° 1'	30° 1'	1936	1975	40	28	5.8			
150	0723 041 W	A91B	SWEETWATERS	-23°11'	30° 2'	1903	1940	38	44	9.6			
151	0723 055 W	B82D	DORINGBOOM	-23°26'	30° 2'	1903	1963	61	34	4.6			
152	0723 070 W	A91C	ELIM - HOSP	-23°10'	30° 4'	1903	2008	106	62	4.9			
153	0723 071 W	A91B		-23°11'	30° 3'	1939	1957	19	27	11.8			
154	0723 113 W	B82D	VOORSPOED - BOS	-23°22'	30° 5'	1949	2008	60	22	3.1			
155	0723 114 W	B82D	MYNGENOEGEN	-23°24'	30° 4'	1931	1965	35	17	4			
156	0723 126 W	A91B	BEJA	-23° 5'	30° 6'	1931	1969	39	31	6.6			
157	0723 155 W	A91C	GOEDEHOOP - BOS	-23° 4'	30° 8'	1922	2007	86	28	2.7			
158	0723 173 W	B82D	WILTONVALE	-23°23'	30° 6'	1931	1936	6	5	6.9			
159	0723 176 W	B82D	GROOTFONTEIN	-23°26'	30° 6'	1920	1930	11	4	3			
160	0723 182 W	A91A	SHEFEERA	-23° 2'	30° 7'	1947	2008	62	22	3			
161	0723 231 W	B82D	BONTFONTEIN	-23°21'	30° 9'	1922	1996	75	49	5.4			
162	0723 243 P	A91C	MUIRHEAD O LOUISTRICHARD	-23° 3'	30° 9'	0	0	1	0	0			
163	0723 278 W	A91C	GEVONDEN	-23° 7'	30° 9'	1914	1991	78	262	28			
164	0723 278AW	A91C	LA ROCHELLE - SAPEKOE	-23° 8'	30°10'	1985	1992	8	18	18.8			
165	0723 292 W	B82D	ZOETFONTEIN	-23°22'	30°10'	1913	1916	4	15	31.3			
166	0723 327 W	B82B	MOOIWATER	-23°28'	30°12'	1951	1974	24	10	3.5			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
167	0723 331 W	A91D	TIMBADOLA - BOS	-23° 1'	30°12'	1931	1998	68	26	3.2			
168	0723 332 A	A91D	LEVUBU:CITIM	-23° 1'	30°12'	0	0	1	0	0			
169	0723 334 W	A91C	NOOITGEDACHT	-23° 4'	30°11'	1927	2008	82	33	3.4			
170	0723 334AW	A91C	GROOTGELUK	-23° 4'	30°11'	1916	1925	10	13	10.8			
171	0723 338 W	A91C	MAMBEDI RIVER - SAPEKOE	-23° 8'	30°12'	1985	1998	14	15	8.9			
172	0723 338AW	A91C	DRIEFONTEIN	-23° 8'	30°12'	1922	1986	65	22	2.8			
173	0723 359 W	B82B	JACHTSDRIFT	-23°30'	30°13'	1908	1934	27	21	6.5			
174	0723 363 W	A91D	KLEIN AUSTRALIE - BOS	-23° 3'	30°13'	1903	2008	106	64	5			
175	0723 469 W	B82D	SCHAAPLAAGTE	-23°20'	30°16'	1954	1972	19	2	0.9			
176	0723 485 A	A91D	LEVUBU.	-23° 5'	30°17'	1941	1988	48	60	10.4			
177	0723 485 W	A91C	LEVUBU	-23° 6'	30°17'	1939	1991	53	326	51.3			
178	0723 485AW	A91D	LEVUBU - AGR	-23° 5'	30°17'	1919	2008	90	542	50.2			
179	0723 513 W	A91D	TSHAKHUMA	-23° 3'	30°18'	1906	2008	103	56	4.5			
180	0723 513AW	A91D	TSHAKHUMA	-23° 3'	30°18'	1984	1986	3	24	66.7			
181	0723 515 A	A91D	LEVUBU ARBOR	-23° 5'	30°18'	1986	1988	3	14	38.9			
182	0723 603 W	A91E	TSIANDA	-23° 3'	30°22'	1953	2008	56	37	5.5			
183	0723 633 A	A91E	VENDA:LWAMONDO P/S	-23° 3'	30°22'	1986	1990	5	24	40			
184	0723 648 W	B82D	PLAIZERFONTEIN	-23°18'	30°23'	1950	1953	4	8	16.7			
185	0723 664 W	A91E	THOHOYANDOU WO	-23° 4'	30°23'	1919	2008	90	12	1.1			
186	0765 869 W	A91A	FLEURFONTEIN	-23° 0'	29°59'	1933	1972	40	11	2.3			
187	0765 898 W	A91A	STERKWATER	-22°59'	30° 0'	1931	1958	28	21	6.3			
188	0766 028 W	A91A	VREEMDELING	-23° 0'	30° 1'	1937	2008	72	11	1.3			
189	0766 030 W	A91A	ROODEWAL - BOS	-23° 0'	30° 2'	1947	2008	62	23	3.1			
190	0766 059 W	A91A	FIG TREE	-22°59'	30° 3'	1922	1933	12	13	9			
191	0766 150 W	A91A	PISANGHOEK	-23° 0'	30° 5'	1907	1933	27	69	21.3			X
192	0766 480 W	A91E	ENTABENI - BOS	-23° 1'	30°18'	1922	2008	87	39	3.7			X
193	0766 509 W	A91G	MATIWA - BOS	-22°59'	30°17'	1931	2008	78	28	3			
194	0766 536 W	A91G	MANDALA	-22°56'	30°18'	1931	1941	11	28	21.2			

#	SAWS No.	Quat	Name	Location		Period available			Months missing / unreliable		Used in earlier studies		
				Lat. (°S)	Long. (°E)	Start	End	Length	No.	As %	WR2005	Mokolo	Monograph
195	0766 568 W	A91G	MAFELA PLANTATION	-22°58'	30°19'	1984	1999	16	16	8.3			
196	0766 596 W	A91G	VONDA - BOS	-22°56'	30°21'	1963	2008	46	10	1.8			
197	0766 628 W	A91E	TSHIVHASIE TEA - VENDA	-22°58'	30°21'	1919	2008	90	15	1.4			
198	0766 715 W	A91G	MUKUMBANI TEA - VENDA	-22°55'	30°24'	1919	2008	90	28	2.6			
199	0766 717 W	A91G	PHIPHIDI	-22°57'	30°24'	1985	2008	24	21	7.3			
200	0766 748 W	A91E	BEUSTER	-22°58'	30°26'	1942	1953	12	6	4.2			
201	0766 779 W	A91E	PALMARYVILLE	-22°59'	30°26'	1906	2008	103	75	6.1			
202	0766 827 W	A92A	RAMBUDA	-22°48'	30°25'	1953	2008	56	31	4.6			X
203	0766 837 W	A91E	SIBASA	-22°57'	30°28'	1903	1985	83	40	4			
204	0766 837AW	A91E	SIBASA AMBASSADE	-22°57'	30°28'	1980	1993	14	16	9.5			
205	0766 863 A	A91G	GOOLDVILLE HOSPITAAL	-22°53'	30°29'	1934	1971	38	12	2.6			
206	0766 863 W	A91G	GOOLDVILLE - HOSP	-22°53'	30°29'	1939	1983	45	19	3.5			
207	0766 888 A	A92A	VENDA:TSHIOMBO P/S	-22°48'	30°30'	1982	1990	9	36	33.3			
208	0767 046 W	A92A	TSHANDAMA	-22°46'	30°32'	1981	1993	13	16	10.3			
209	0811 475 A	A92D	VENDA:SIGONDE. P/S	-22°25'	30°46'	1982	1990	9	24	22.2			

Appendix B

Bar charts of rainfall stations

Appendix C

Rainfall station usage summary

Table C.1: Summary of rainfall stations used and excluded from the Limpopo Monograph

Rainfall Zone	Rainfall station	Monograph		Excluded		Limpopo Reconciliation		
		Start	End	Start	End	Start	End	Record length
A4A	0630 862 W	1925	1969			1925	1969	45
	0630 886 W	1936	2010	1965	1979	1936	1964	29
						1980	2010	31
	0631 011 W	1922	1935			1922	1935	14
		1939	1949			1939	1949	11
		1953	1984			1953	1984	32
	0631 047 W	1926	1940	1926	1940			-
		1970	1980	1970	1980			-
	0631 337 W	1937	2010	1970	1977	1937	1969	33
						1978	2010	33
0631 520 W	1920	1951			1920	1951	32	
0631 596 W	1921	1979			1921	1979	59	
A4B	0630 511 W	1958	1999			1958	1999	42
	0631 337 W	1937	2010	1967	1984	1937	1966	30
						1985	2010	26
	0672 748 W	1920	1951			1920	1951	32
		1953	2001			1953	2001	49
	0673 015 W	1920	1950			1920	1950	31
	0673 128 W	1920	1936			1920	1936	17
		1938	1974			1938	1974	37
	0673 160 W	1975	2003			1975	2003	29
	0673 239 W	1962	2003			1962	2003	42
	0673 284 W	1953	1988			1953	1988	36
	0673 636 W	1958	2000	1958	2000			-
	0673 645 W	1922	1951	1922	1951			-
0717 595 W	1925	1951	1925	1951	1967	2010	44	
	1967	2010					-	
A5A	0632 465 W	1920	1951			1920	1951	32
	0632 726 W	1931	1978			1931	1978	48
	0632 797 W	1941	1963			1941	1963	23
	0632 886 W	1923	1939			1923	1939	17
	0633 041 W	1955	2010			1955	2010	56
	0675 712 W	1960	2002			1960	2002	43
A5B	0632 274 W	1935	2010			1935	2010	76
	0674 855 W	1952	1984			1952	1984	33
	0675 182 W	1920	1939			1920	1939	20
		1941	2010			1941	2010	70
	0675 712 W	1960	2002			1960	2002	43
	0675 761 W	1926	1954			1926	1954	29

Table C.1 (Continue)

Rainfall Zone	Rainfall station	Monograph		Excluded		Limpopo Reconciliation		
		Start	End	Start	End	Start	End	Record length
A5C	0675 125 W	1932	1967			1932	1967	36
		1969	1977			1969	1977	9
	0675 182 W	1920	1939			1920	1939	20
		1941	2010			1941	2010	70
	0718 772 W	1949	1994			1949	1994	46
	0718 874 W	1951	2010			1951	2010	60
	0719 467 W	1936	1964	1936	1964			-
	0761 810 W	1965	2001			1965	2001	37
0762 532 W	1937	1985			1937	1985	49	
A6A	0589 586 W	1932	1942	1932	1942			-
		1944	1979	1944	1979			-
	0589 670 W	1920	1938			1920	1938	19
		1944	1967			1944	1967	24
		1970	1993			1970	1993	24
	0589 732 W	1920	2010	1920	1948	1949	2010	62
	0589 766 W	1924	1931	1924	1931			-
	0589 877 W	1920	1974			1920	1974	55
	0590 106 W	1920	1952			1920	1952	33
0590 307 W	1921	2010			1921	2010	90	
A6B	0589 877 W	1920	1974			1920	1974	55
	0590 307 W	1921	2010			1921	2010	90
	0590 361 W	1920	2001			1920	2001	82
	0590 486 W	1920	1994			1920	1994	75
	0633 497 W	1920	1953			1920	1953	34
	0633 503 W	1939	1967	1939	1967			-
	0633 796 W	1920	1983	1989	2004	1920	1983	64
		1989	2004					-
0634 050 W	1924	2010			1924	2010	87	
A6C	0633 393 W	1920	1994	1920	1994			-
	0633 463 W	1926	1982	1976	1982	1926	1975	50
	0633 482 W	1920	1942			1920	1942	23
	0633 497 W	1920	1953			1920	1953	34
	0633 796 W	1920	1983	1989	2004	1920	1983	64
		1989	2004					-
	0633 881 W	1930	1995			1930	1995	66
	0634 011 W	1966	1992			1966	1992	27
	0634 131 W	1920	1983	1920	1983			-
	0634 181 W	1962	1992			1962	1992	31
0676 237 W	1941	2010			1941	2010	70	

Table C.1 (Continue)

Rainfall Zone	Rainfall station	Monograph		Eliminated		Limpopo Reconciliation		
		Start	End	Start	End	Start	End	Record length
A6D	0633 393 W	1920	1994	1970	1994	1920	1970	51
	0675 182 W	1920	2010	1920	2010			-
	0675 712 W	1960	2002			1960	2002	43
	0675 761 W	1926	1954			1926	1954	29
	0676 128 W	1948	1990	1948	1964	1965	1990	26
	0676 237 W	1941	2010			1941	2010	70
	0676 473 W	1955	2010			1955	2010	56
	0676 523 W	1955	2004			1955	2004	50
	0676 679 W	1928	1940	1928	1940			-
A6E	0676 523 W	1955	2004			1955	2004	50
	0676 679 W	1928	1940			1928	1940	13
	0676 705 W	1925	1938			1925	1938	14
		1940	1975			1940	1975	36
	0676 783 W	1971	2004	1971	2004			-
	0676 099 W	1948	2010	1989	1992	1948	1988	41
						1993	2010	18
	0677 259 W	1920	2010			1920	2010	91
0720 521 W	1922	1941			1922	1941	20	
A6F	0720 727 W	1920	1925			1920	1925	6
		1933	1963			1933	1963	31
	0762 795 W	1929	1961	1929	1961			-
	0762 814 W	1966	2000			1966	2000	35
	0763 124 W	1963	2010			1963	2010	48
	0763 149 W	1968	2010	1968	2010			-
	0762 675 W	1934	1972			1934	1972	39
	0763 743 W	1955	1968	1955	1968	1970	2003	34
		1970	2003					
	0764 161 W	1931	1989			1931	1989	59
	0765 007 W	1926	1951	1926	1933	1934	1951	18
	0807 598 W	1971	2010			1971	2010	40
	0808 253 W	1963	2010			1963	2010	48
0720 521 W	1922	1941			1922	1941	20	
A7A	0677 834 W	1920	1932	1920	1932			-
		1934	2010	1934	2010			-
	0678 023 W	1920	2010	1920	2010			-
	0678 132 W	1929	1991			1929	1991	63
	0678 144 W	1920	1951	1920	1951			-
		1953	2004	1953	2004			-
	0678 381 W	1948	2010			1948	2010	63
	0678 722 W	1926	1987			1926	1987	62
0722 082 W	1923	2010	1923	2010			-	

Table C.1 (Continue)

Rainfall Zone	Rainfall station	Monograph		Eliminated		Limpopo Reconciliation		
		Start	End	Start	End	Start	End	Record length
A7A	0722 099 W	1936	2010	1936	2010			-
	0722 277 W	1927	2010			1927	2010	84
	0722 391 W	1923	1950	1923	1950			-
	0722 571 W	1920	1988			1920	1988	69
	0722 614 W	1920	2010	1920	2010			-
	0722 700 W	1923	1993			1923	1993	71
	0722 721 W	1941	2004	1941	2004			-
A7B	0677 259 W	1920	2010			1920	2010	91
	0677 456 W	1985	2002			1985	2002	18
	0677 562 W	1920	1950	1920	1950			-
	0721 197 W	1920	1976	1920	1976			-
	0721 257 W	1928	1980			1928	1980	53
	0721 592 W	1971	1989	1971	1989			-
	0721 618 W	1920	1944			1920	1944	25
		1946	1975			1946	1975	30
	0721 665 W	1956	2010	1956	2010			-
	0721 772 W	1920	1964			1920	1964	45
	0722 277 W	1927	2010			1927	2010	84
	0722 082 W	1922	2010	1922	2010			-
0722 099 W	1937	2010	1937	2010			-	
A7C	0721 725 W	1920	1952	-		1920	1952	33
	0722 277 W	1920	2010	1920	2010			-
	0764 710 W	1937	1977	-		1937	1977	41
	0765 253 W	1962	1986	1962	1986			-
	0765 455 W	1931	1944	-		1931	1944	14
	0765 607 W	1952	1989	-		1952	1989	38
	0808 764 W	1969	1989	1969	1989			-
	0809 285 W	1941	1966	-		1941	1966	26
	0809 706 W	1960	2010	-		1960	2010	51
	0810 081 W	1959	2010	-		1959	2010	52
A8A	0722 721 W	1960	2010			1960	2010	51
	0765 825 W	1927	1962			1927	1962	36
	0766 150 W	1920	1931			1920	1931	12
	0766 201 W	1965	2010			1965	2010	46
	0766 269 W	1985	2010			1985	2010	26
	0766 324 W	1931	1989			1931	1989	59
	0766 480 W	1922	1950			1922	1950	29
		1956	2010			1956	2010	55

Table C.1 (Continue)

Rainfall Zone	Rainfall station	Monograph		Eliminated		Limpopo Reconciliation		
		Start	End	Start	End	Start	End	Record length
A8B	0766 133 W	1931	1952			1931	1952	22
	0766 150 W	1920	1931			1920	1931	12
	0766 269 W	1985	2010	1985	2010			26
	0766 276 W	1959	2010			1959	2010	52
	0766 462 W	1966	1979			1966	1979	14
	0766 827 W	1952	2010			1952	2010	59
	0766 842 W	1954	2010			1954	2010	57
	0809 706 W	1959	2010	1959	2010			52
	0810 081 W	1964	2010			1964	2010	47
	0811 055 W	1922	1943			1922	1943	22

Table C.2: Summary of rainfall stations used and extended from the Mokolo study

Rainfall Zone	Rainfall station	Mokolo		Extended		Limpopo Reconciliation		
		Start	End	Start	End	Start	End	Record length
A42A	0589 342 W	1920	1952			1920	1952	33
	0589 371 W	1949	2003			1949	2003	55
	0589 543 W	1925	1977			1925	1977	53
	0589 586 W	1932	1979			1932	1979	48
	0589 670 W	1920	1993			1920	1993	74
	0589 877 W	1920	1977			1920	1977	58
	0632 089 W	1949	2003	2004	2010	1949	2010	62
A42B	0588 573 W	1921	1952			1921	1952	32
	0588 721 W	1920	2003	2004	2010	1920	2010	91
	0632 089 W	1948	2003	2004	2010	1948	2010	63
A42C	0632 089 W	1949	2003	2004	2010	1949	2010	62
	0632 137 W	1920	1948			1920	1948	29
	0632 198 W	1964	2003	2004	2010	1964	2010	47
	0632 297 W	1920	1974			1920	1974	55
	0632 746 W	1922	1942			1922	1942	21
A42D	0632 089 W	1949	2003	2004	2010	1949	2010	62
	0631 564 W	1920	1977			1920	1977	58
	0631 596 W	1920	1979			1920	1979	60
	0632 044 W	1950	1995			1950	1995	46
	0588 721 W	1920	2003	2004	2010	1920	2003	84
A42E	0632 044 W	1949	1995			1949	1995	47
	0632 062 W	1920	1947			1920	1947	28
	0632 198 W	1964	2003	2004	2010	1964	2010	47
	0632 274 W	1934	2003	2004	2010	1934	2010	77
	0632 406 W	1962	2000			1962	2000	39
	0632 410 W	1927	1953			1927	1953	27
A42F	0631 011 W	1922	1984			1922	1984	63
	0631 337 W	1968	2003	2004	2010	1968	2010	43
	0631 520 W	1920	1952			1920	1952	33
	0632 274 W	1934	2003	2004	2010	1934	2010	77
A42G	0632 062 W	1920	1947			1920	1947	28
	0631 337 W	1968	2003	2004	2010	1968	2010	43
	0674 207 W	1938	1998			1938	1998	61
	0632 274 W	1934	2003	2004	2010	1934	2010	77
	0675 117 W	1920	1983			1920	1983	64
A42H	0674 400 W	1967	2003	2004	2010	1967	2010	44
	0674 855 W	1951	1989			1951	1989	39
	0675 117 W	1920	1983			1920	1983	64
	0675 125 W	1931	1977			1931	1977	47
	0675 182 W	1920	2003	2004	2010	1920	2010	91

Table C.2 (Continue)

Rainfall Zone	Rainfall station	Mokolo		Extended		Limpopo Reconciliation		
		Start	End	Start	End	Start	End	Record length
A42J	0674 100 W	1976	2003	2004	2010	1976	2010	35
	0673 636 W	1958	1999			1958	1999	42
	0675 117 W	1920	1983			1920	1983	64
	0718 722 W	1949	1994			1949	1994	46
	0675 182 W	1920	2003	2004	2010	1920	2010	91

Appendix D

Rainfall station coverage and rainfall isohyets

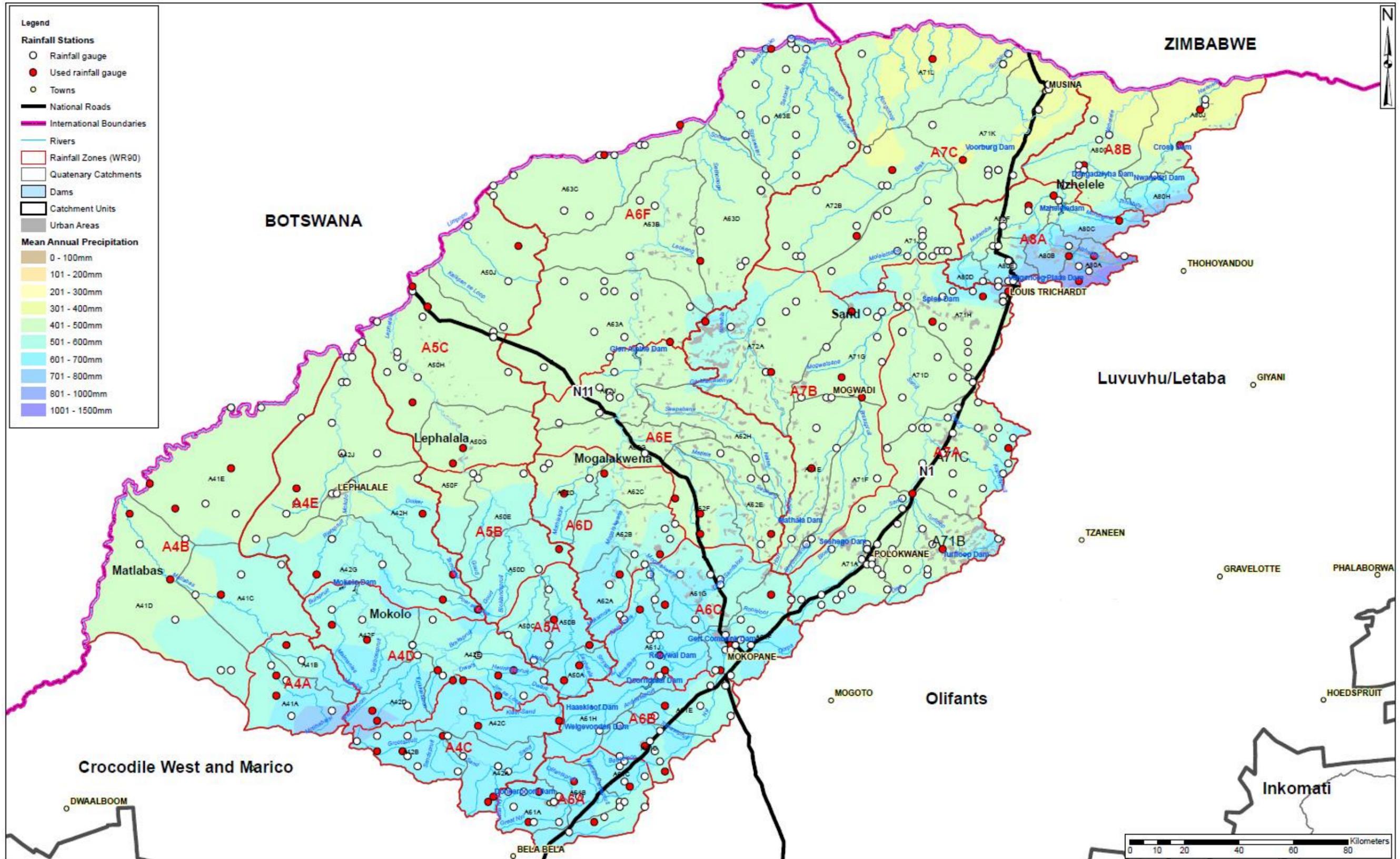


Figure D.1: Rainfall isohyet map and indication of rainfall stations used

Appendix E

Catchment Rainfall Records

Catchment Rainfall Percentage Files (*.sec)

Catchment Rainfall Record Plots

Matlabas River Catchment

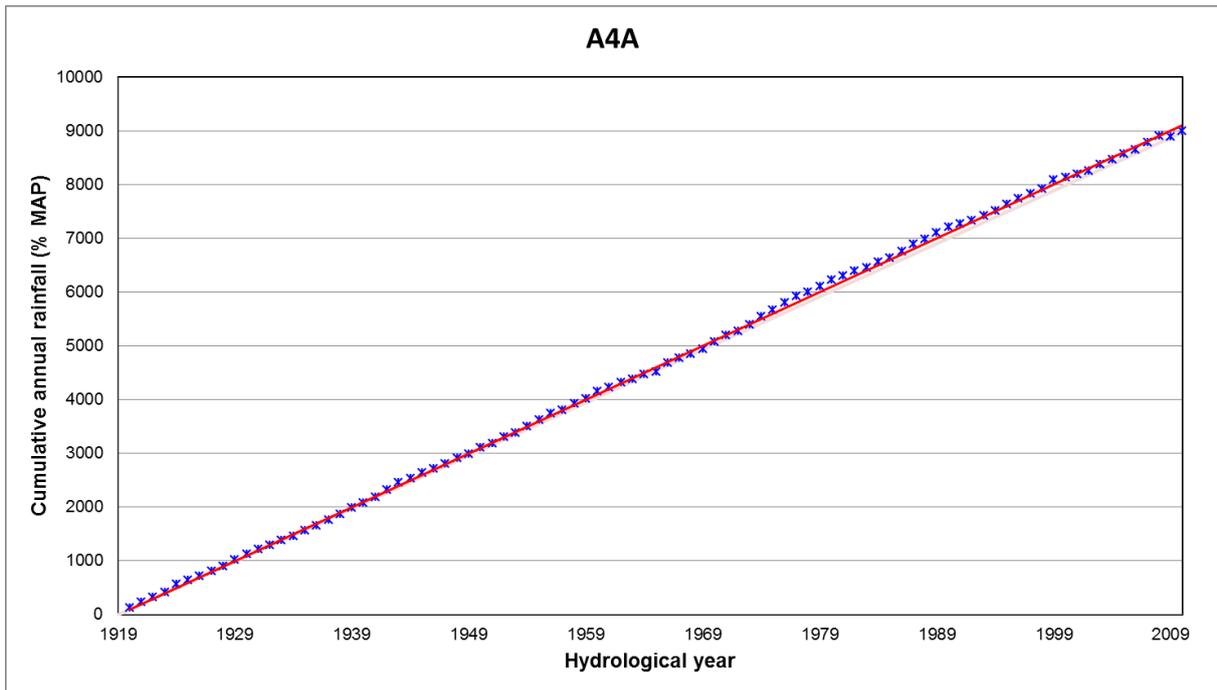


Figure E.1: A4A catchment rainfall single mass plot

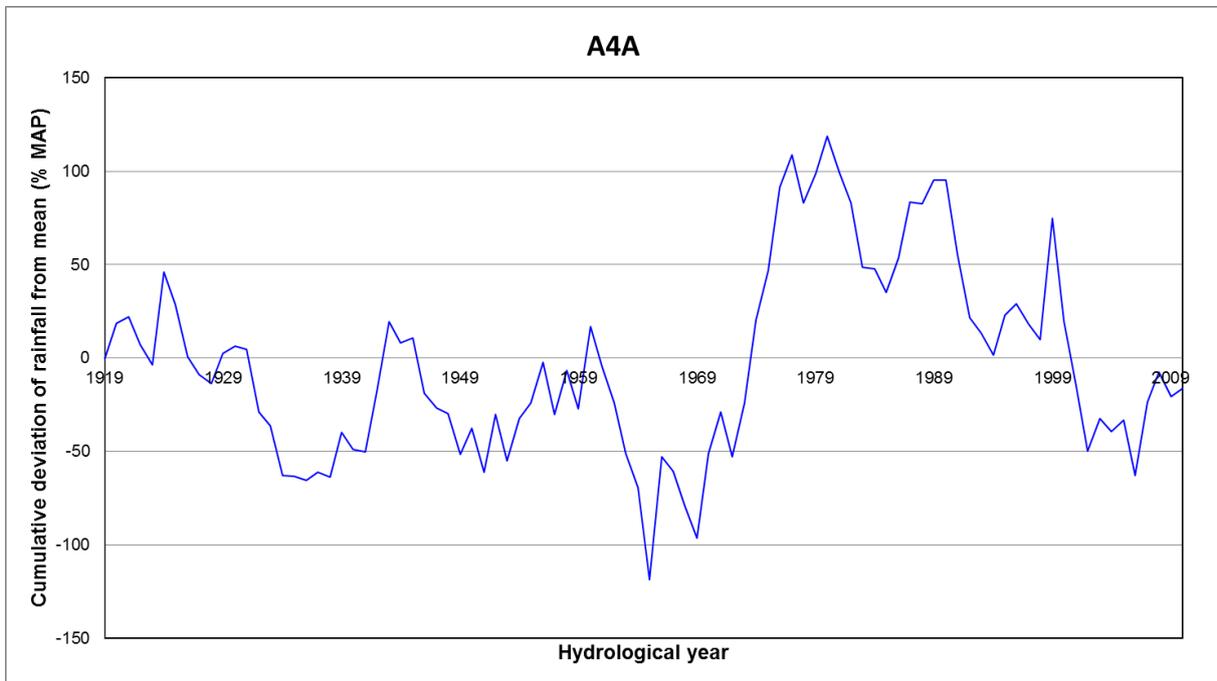


Figure E.2: A4A catchment rainfall cusum plot

Matlabas River Catchment

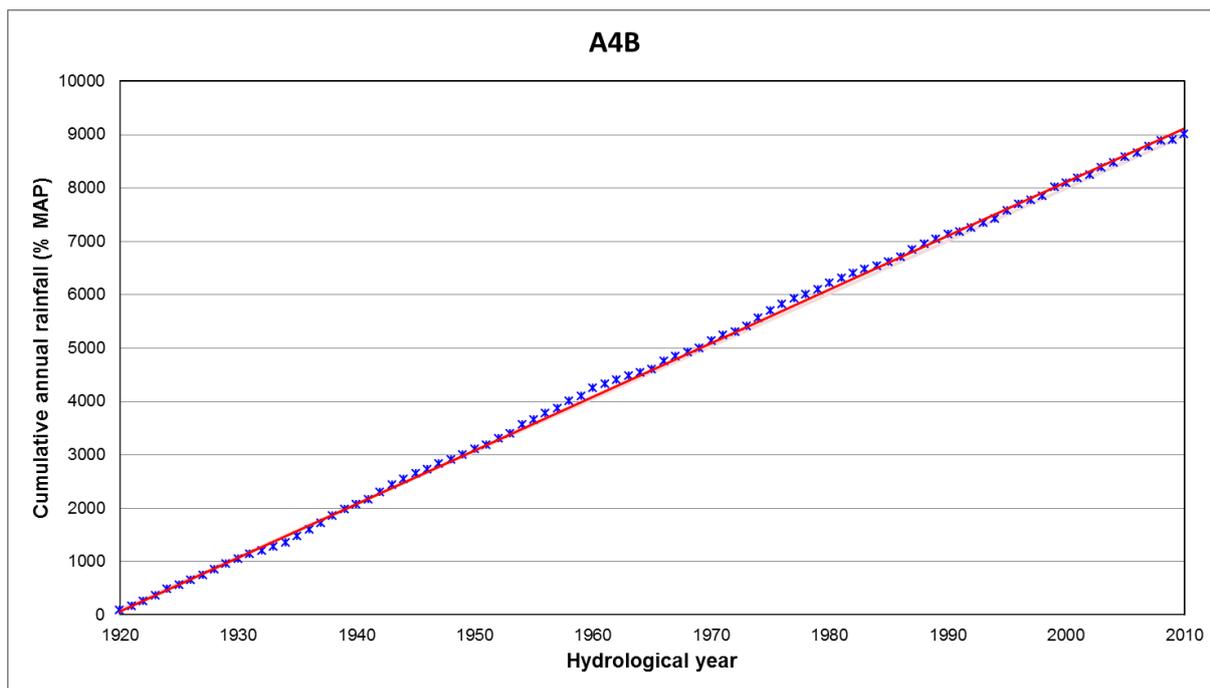


Figure E.3: A4B catchment rainfall single mass plot

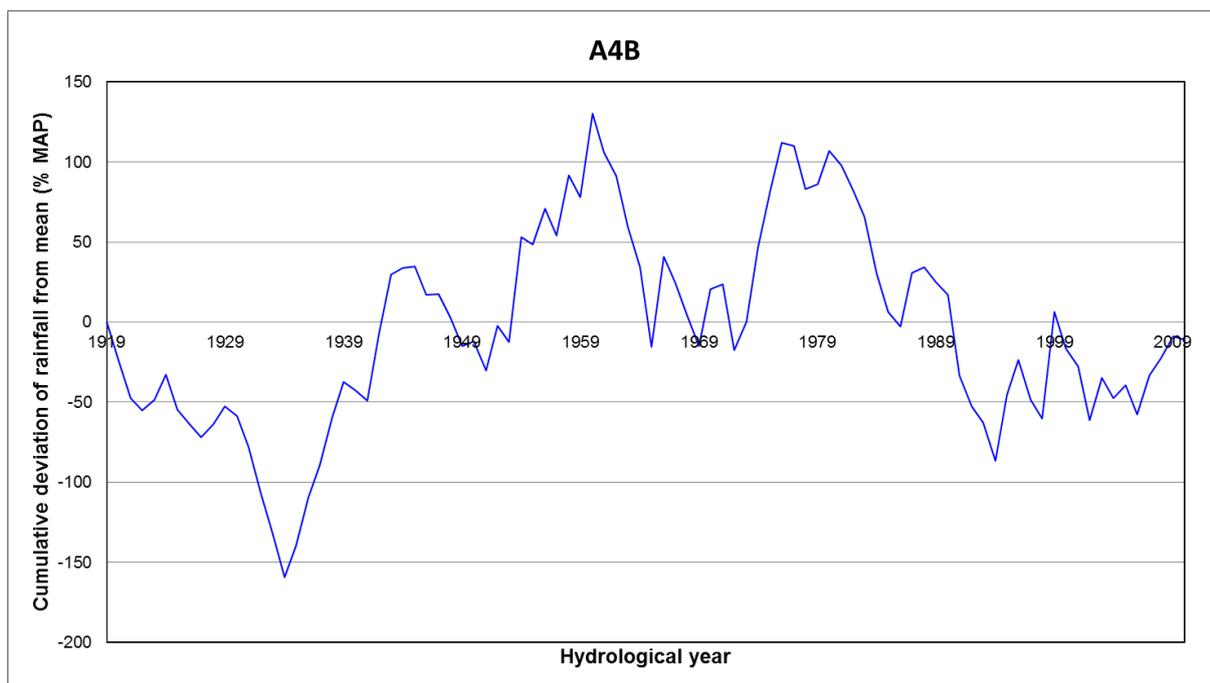


Figure E.4: A4B catchment rainfall cusum plot

Mokolo River Catchment

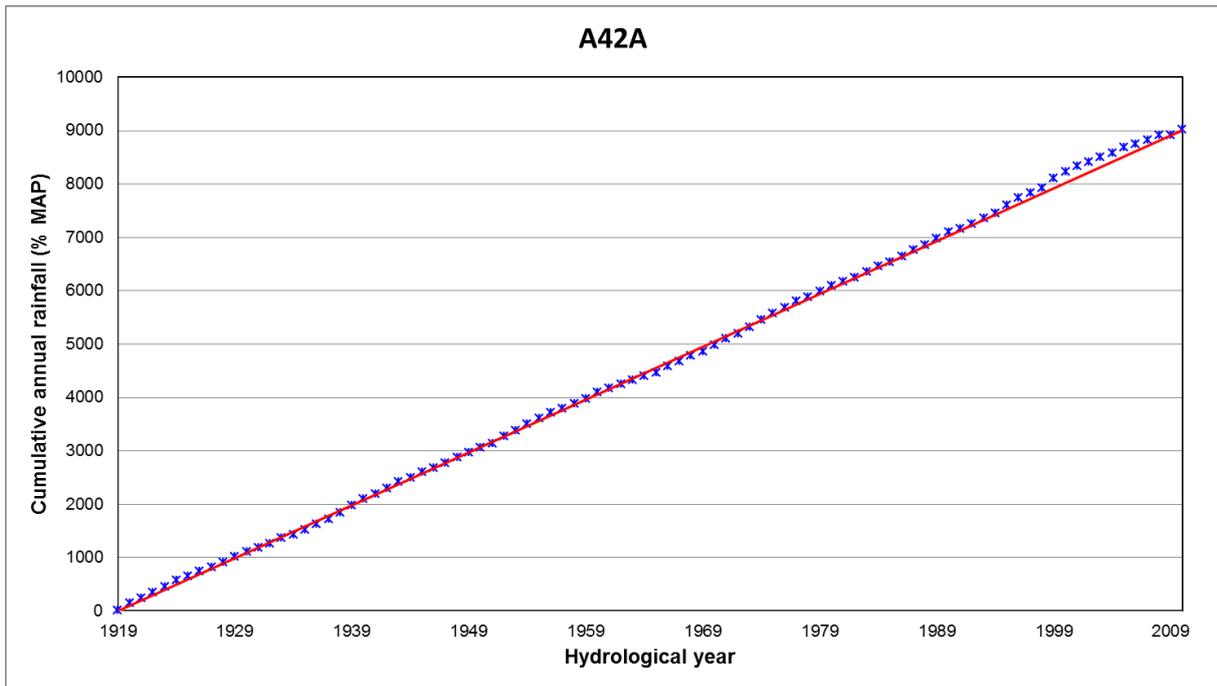


Figure E.5: A42A catchment rainfall single mass plot

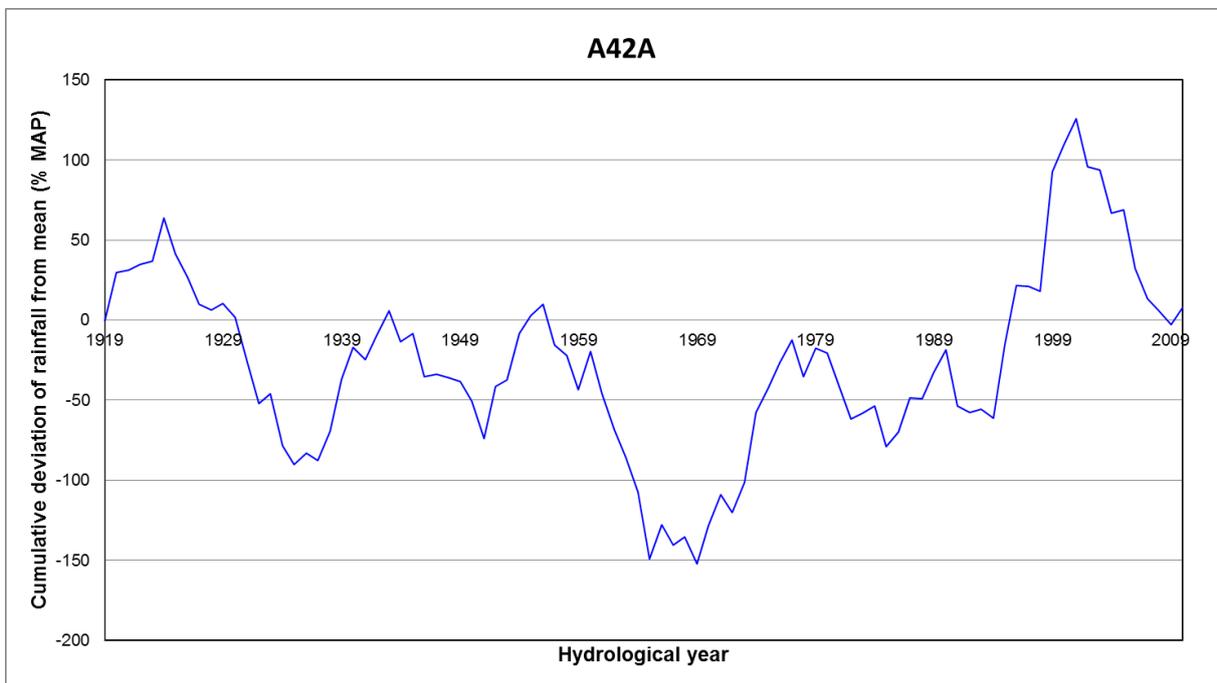


Figure E.6: A42A catchment rainfall cusum plot

Mokolo River Catchment

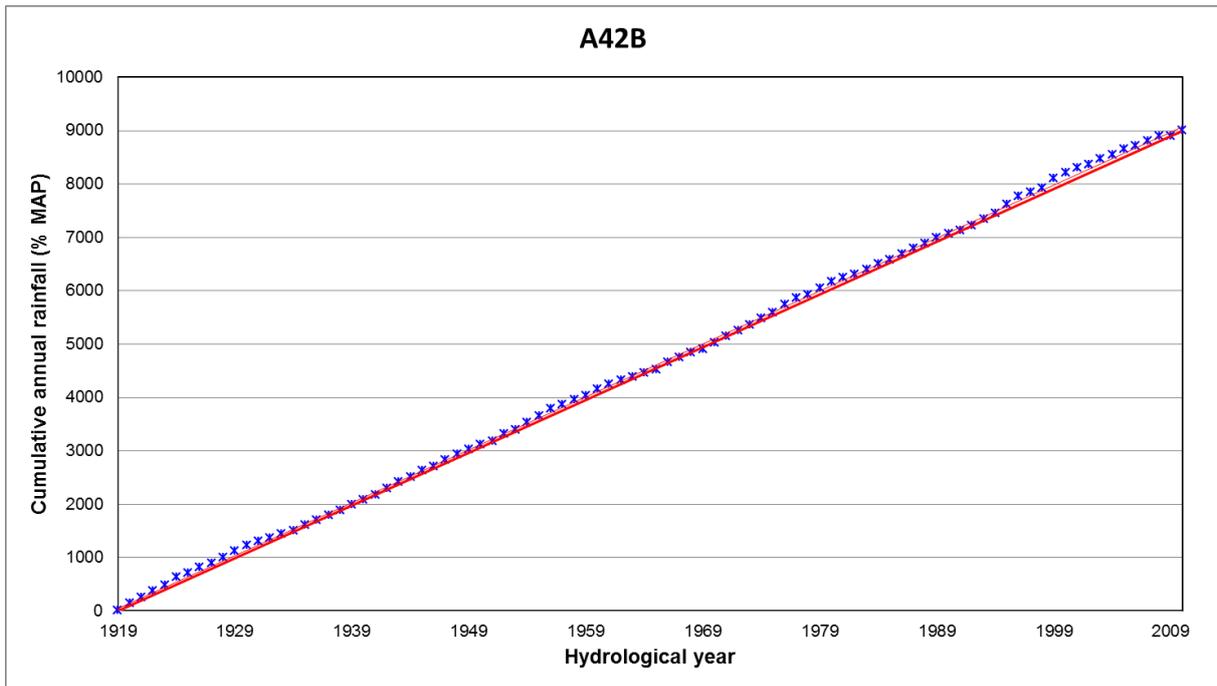


Figure E.7: A42B catchment rainfall single mass plot

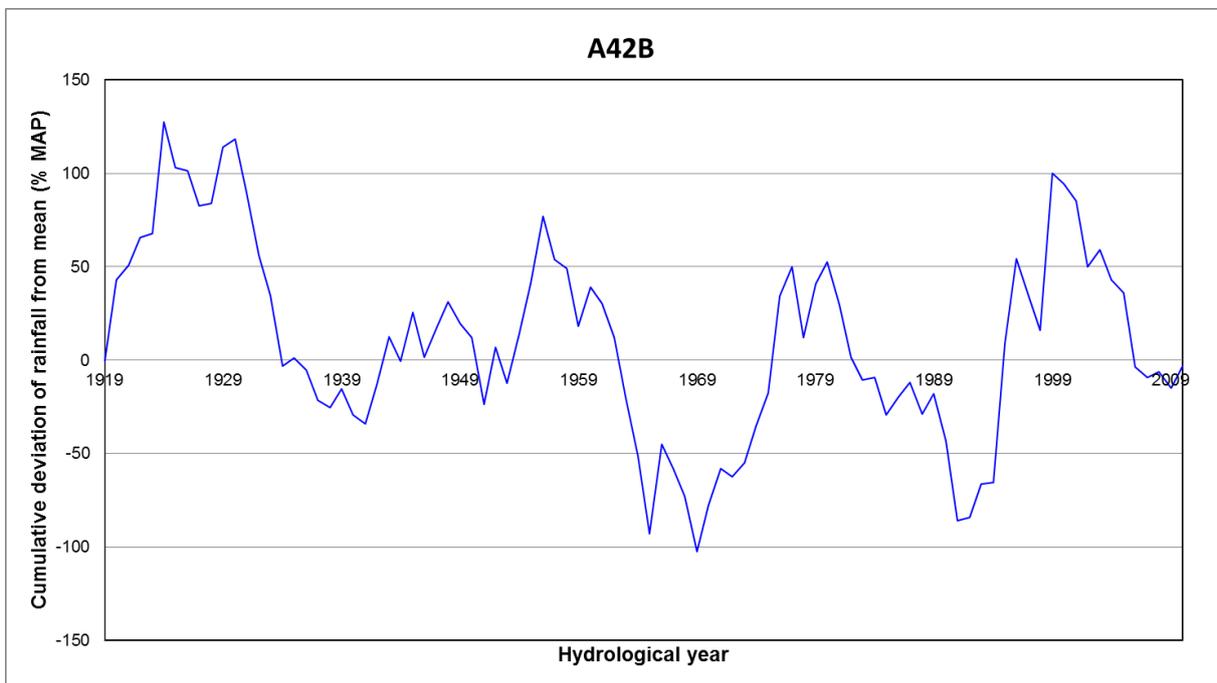


Figure E.8: A42B catchment rainfall cusum plot

Mokolo River Catchment

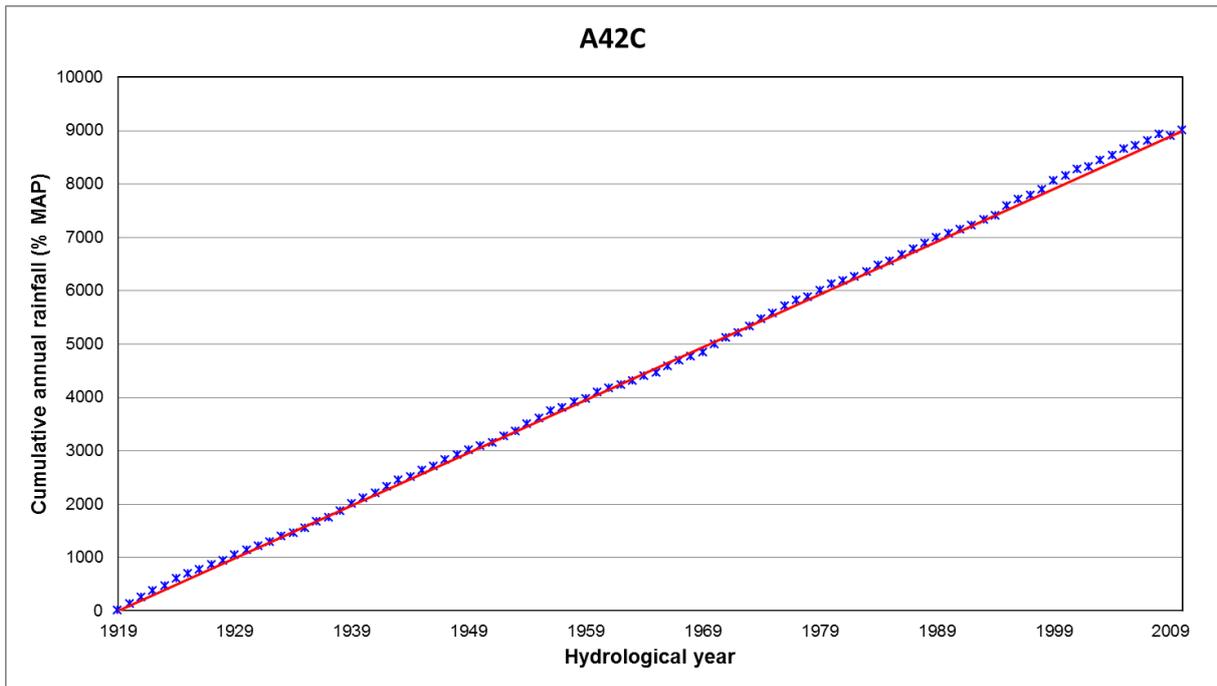


Figure E.9: A42C catchment rainfall single mass plot

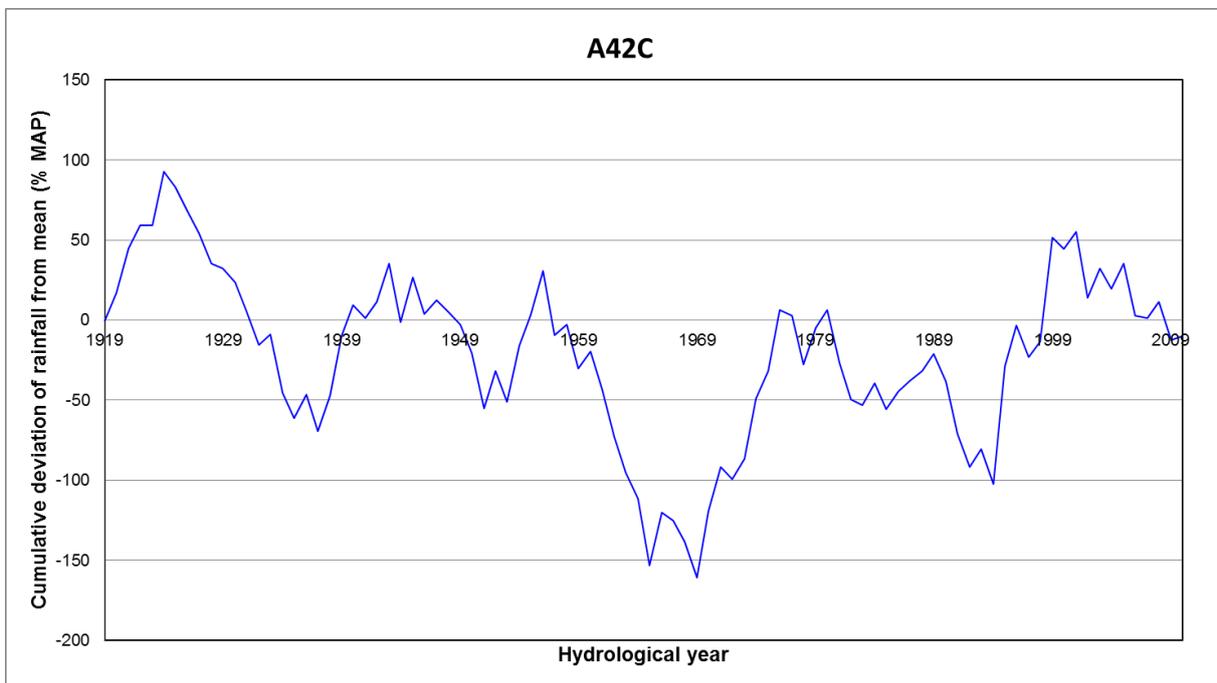


Figure E.10: A42C catchment rainfall cusum plot

Mokolo River Catchment

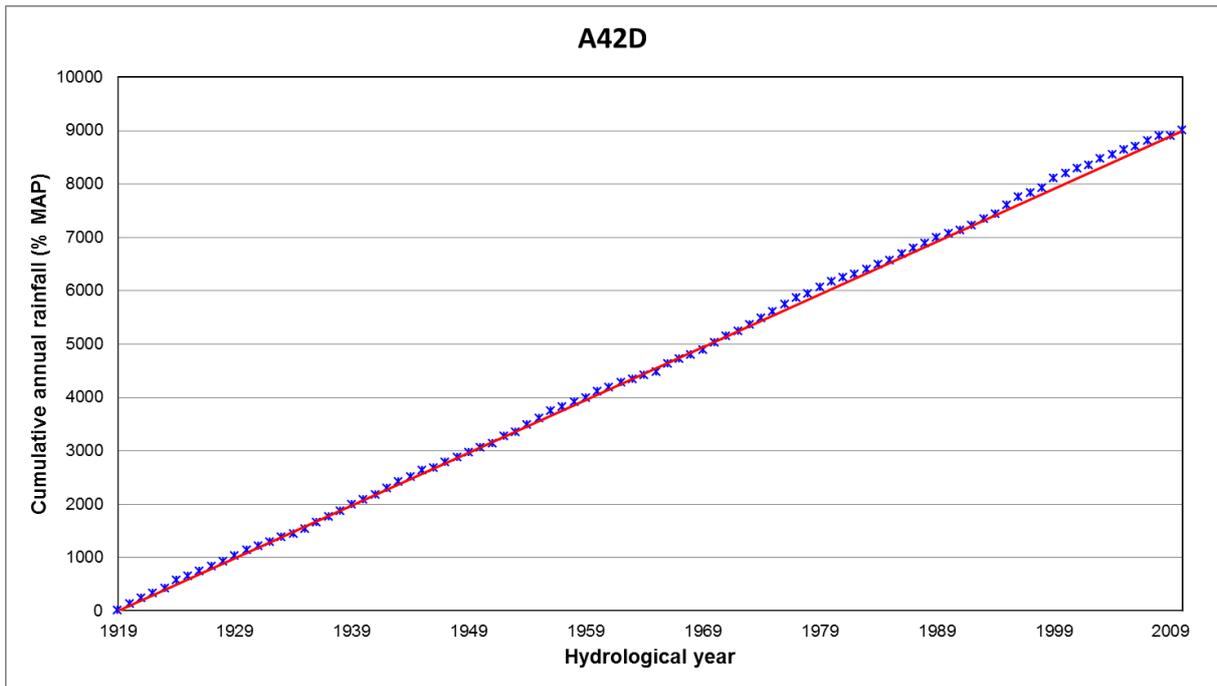


Figure E.11: A42D catchment rainfall single mass plot

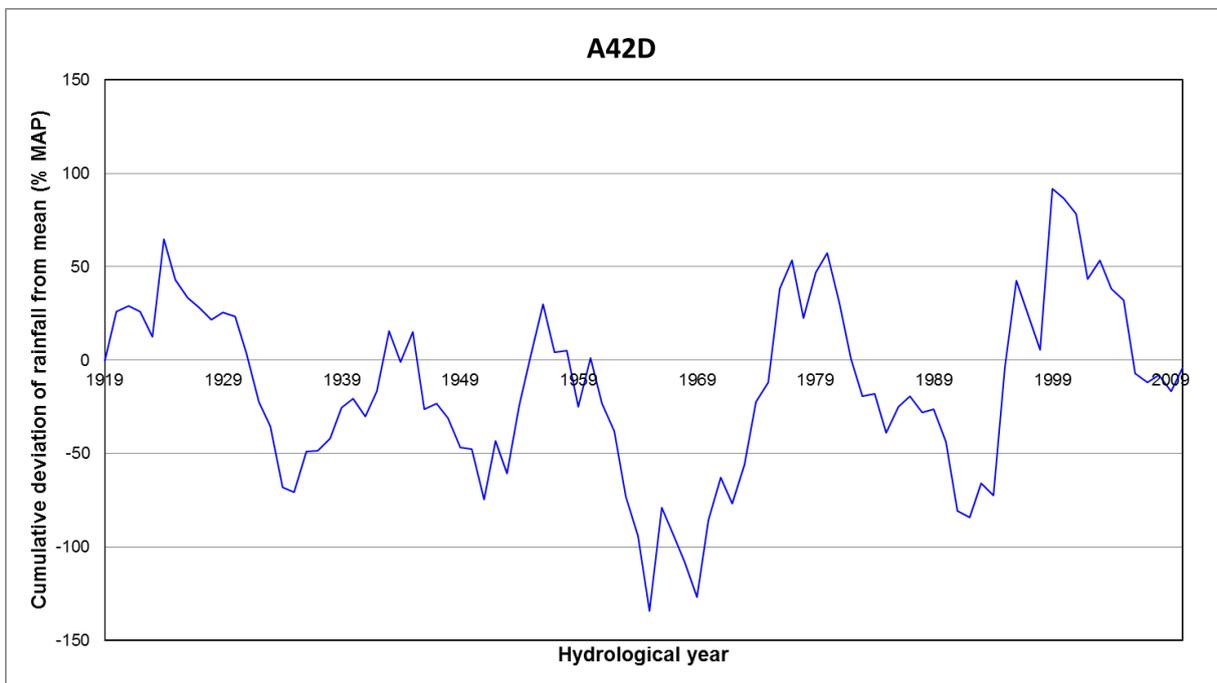


Figure E.12: A42D catchment rainfall cusum plot

Mokolo River Catchment

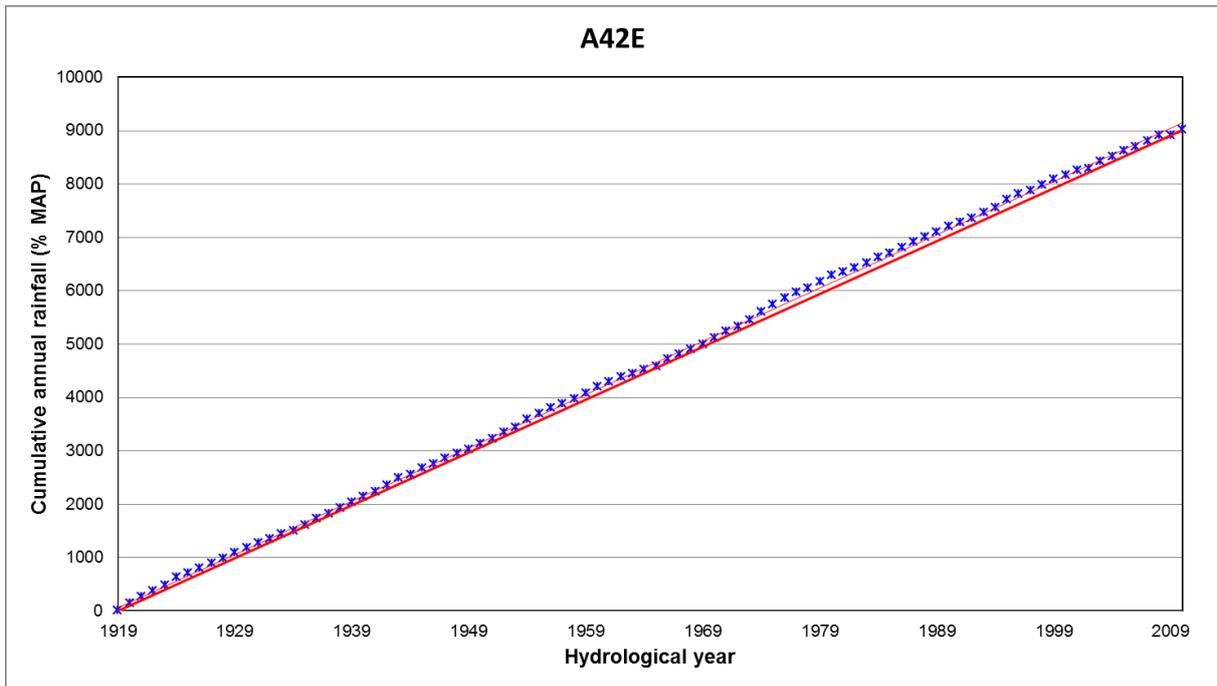


Figure E.13: A42E catchment rainfall single mass plot

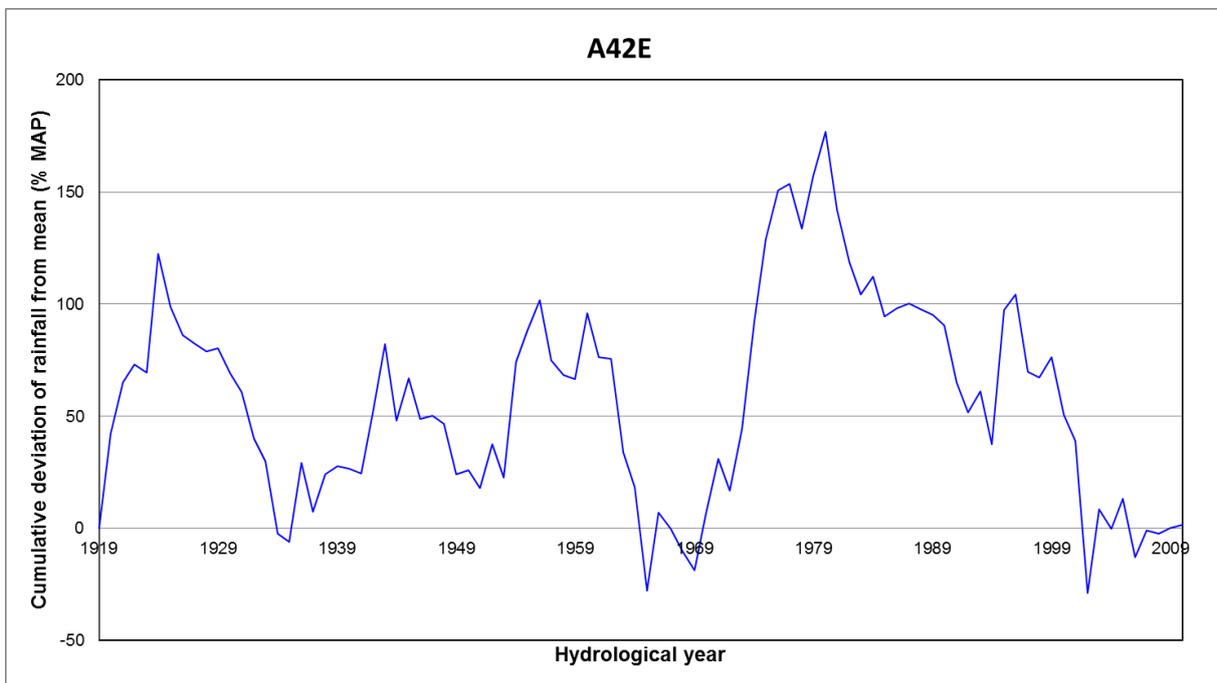


Figure E.14: A42E catchment rainfall cusum plot

Mokolo River Catchment

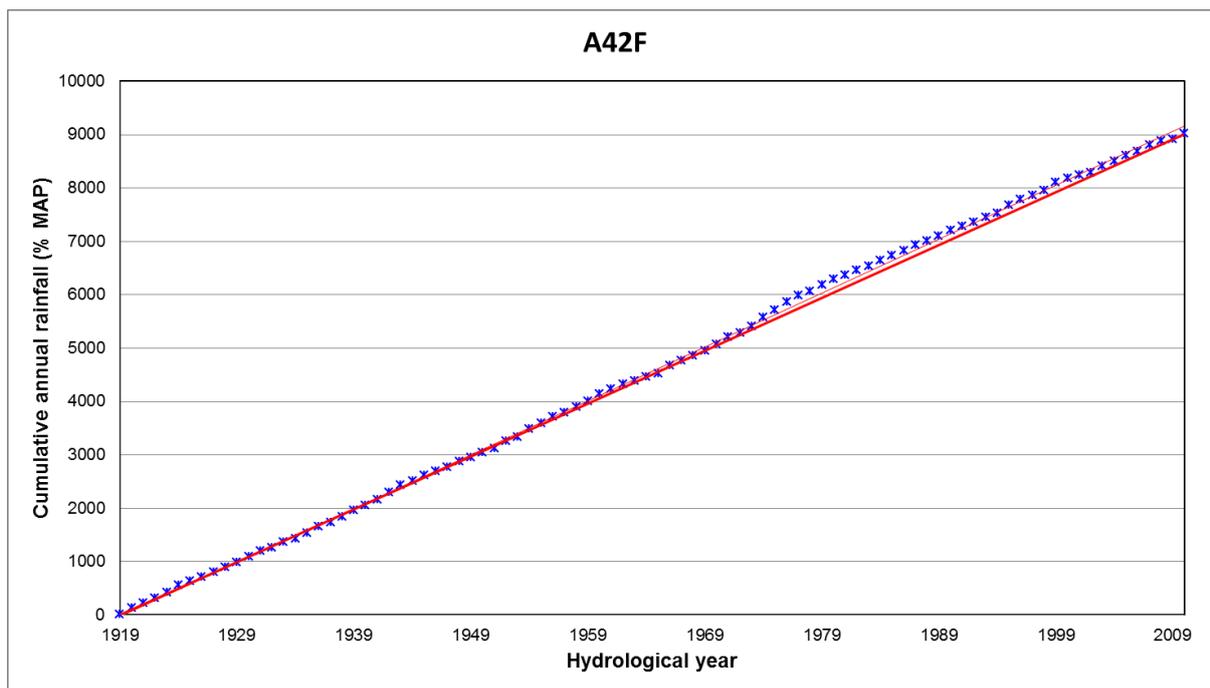


Figure E.15: A42F catchment rainfall single mass plot

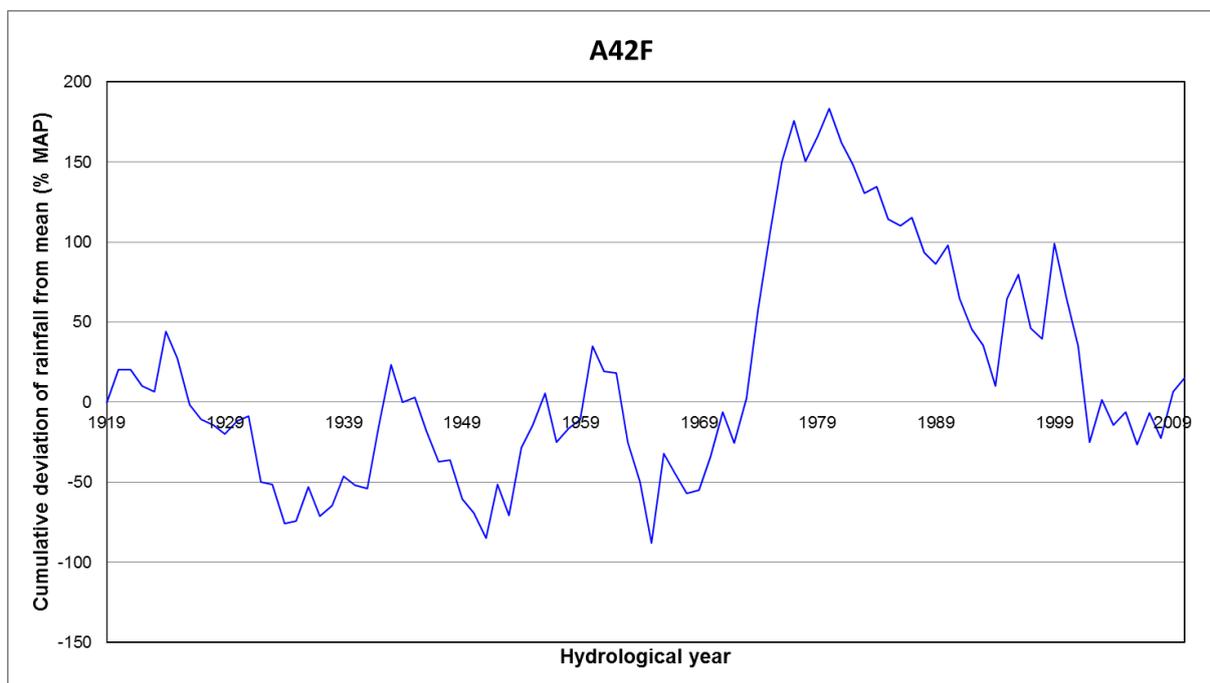


Figure E.16: A42F catchment rainfall cusum plot

Mokolo River Catchment

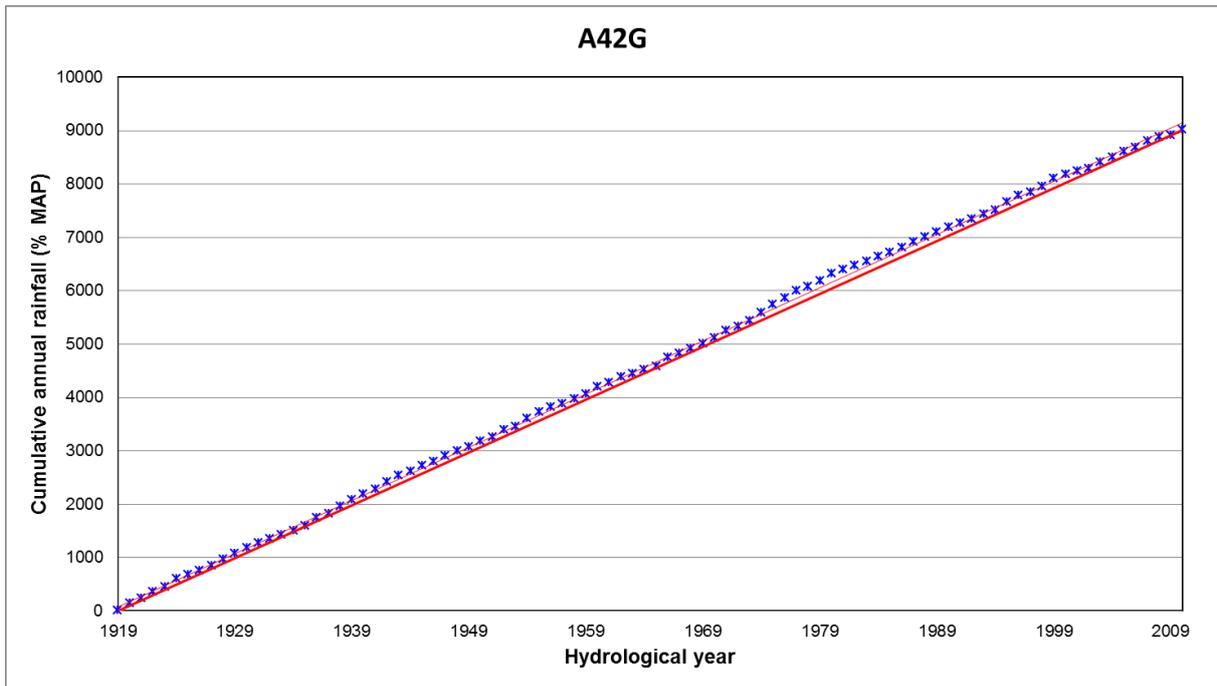


Figure E.17: A42G catchment rainfall single mass plot

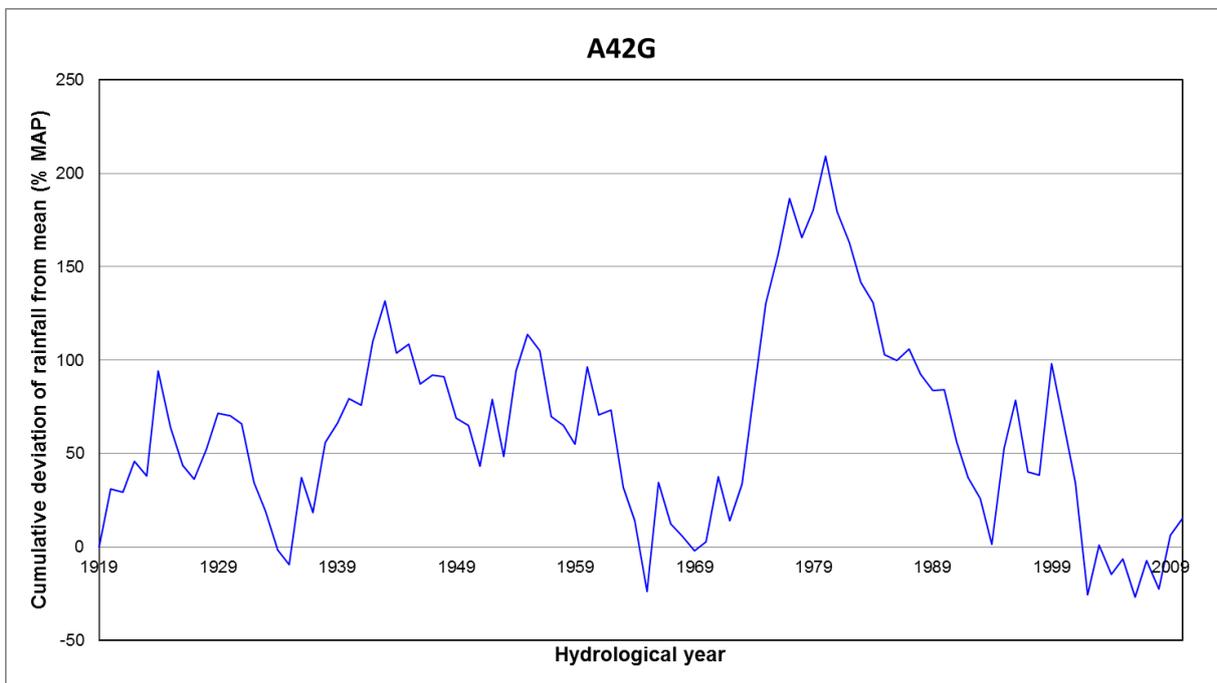


Figure E.18: A42G catchment rainfall cusum plot

Mokolo River Catchment

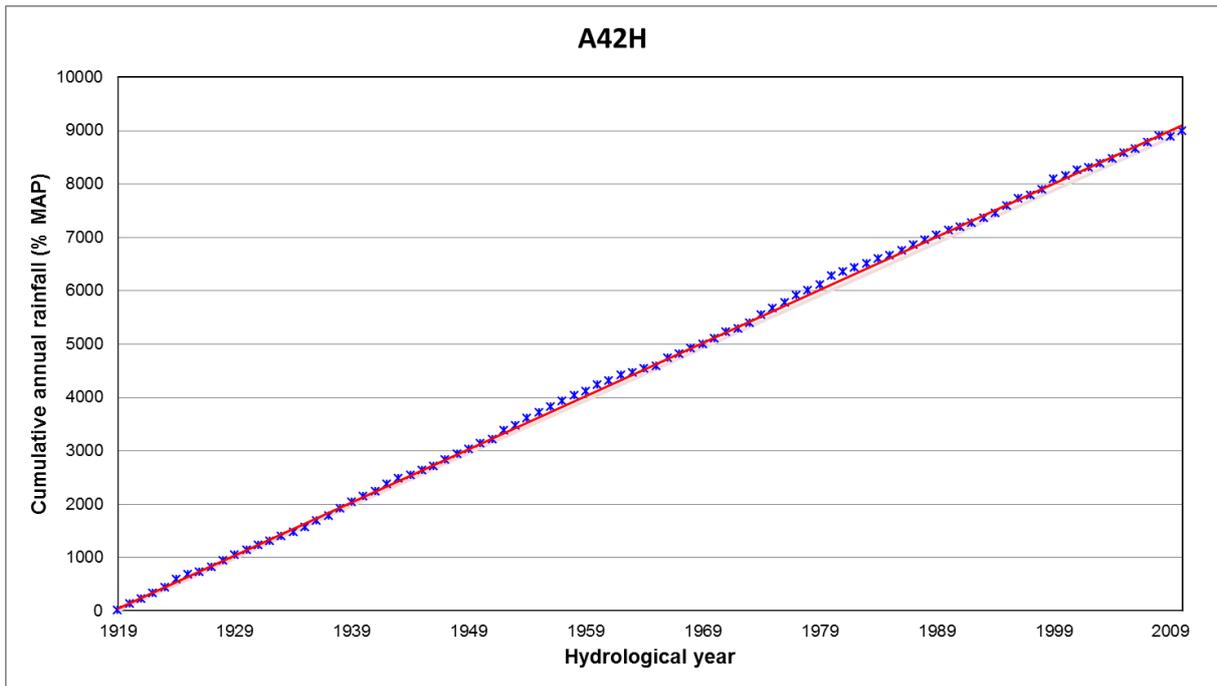


Figure E.19: A42H catchment rainfall single mass plot

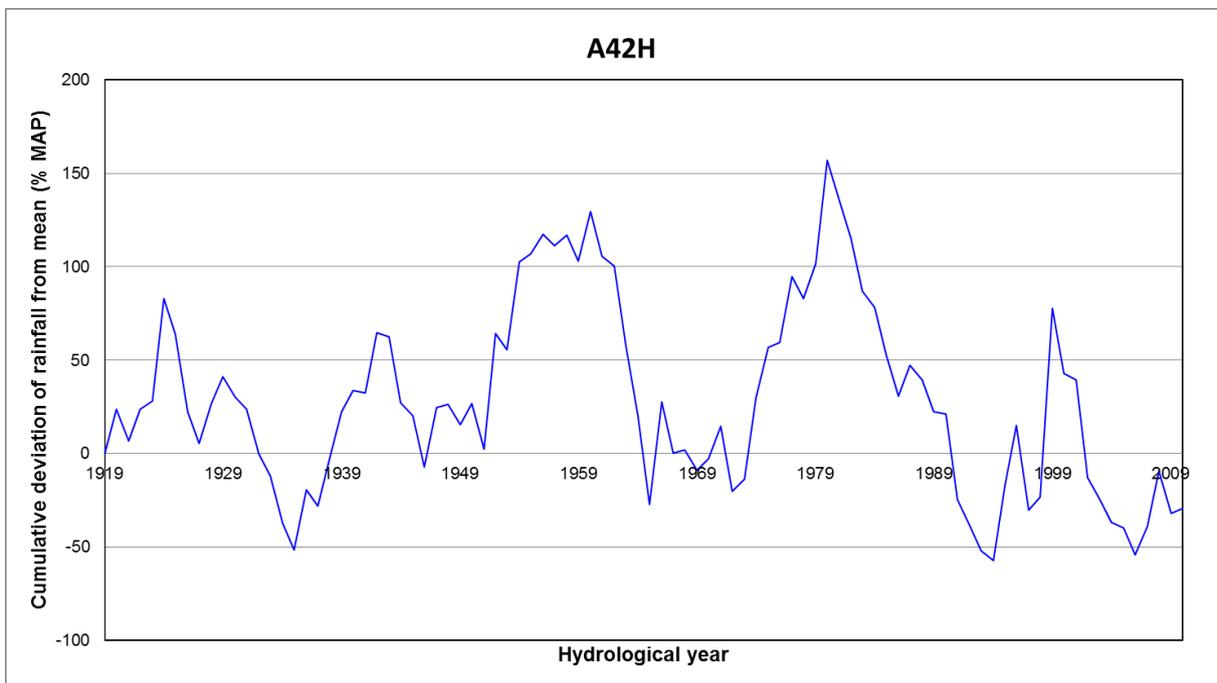


Figure E.20: A42H catchment rainfall cusum plot

Mokolo River Catchment

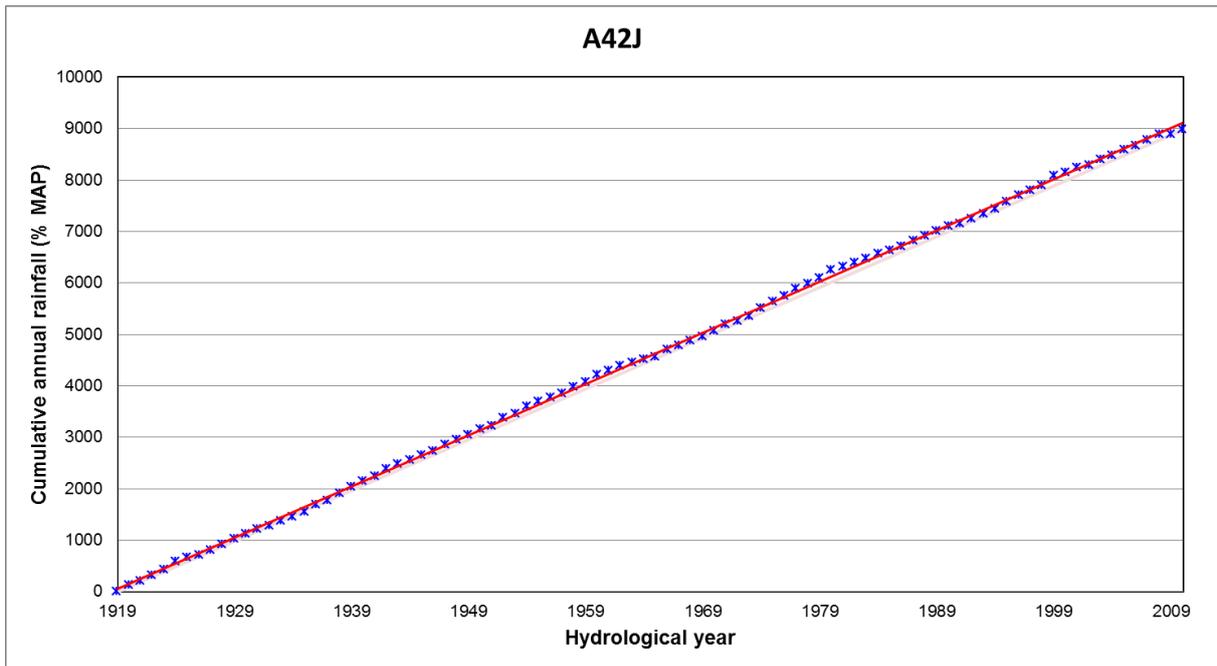


Figure E.21: A42J catchment rainfall single mass plot

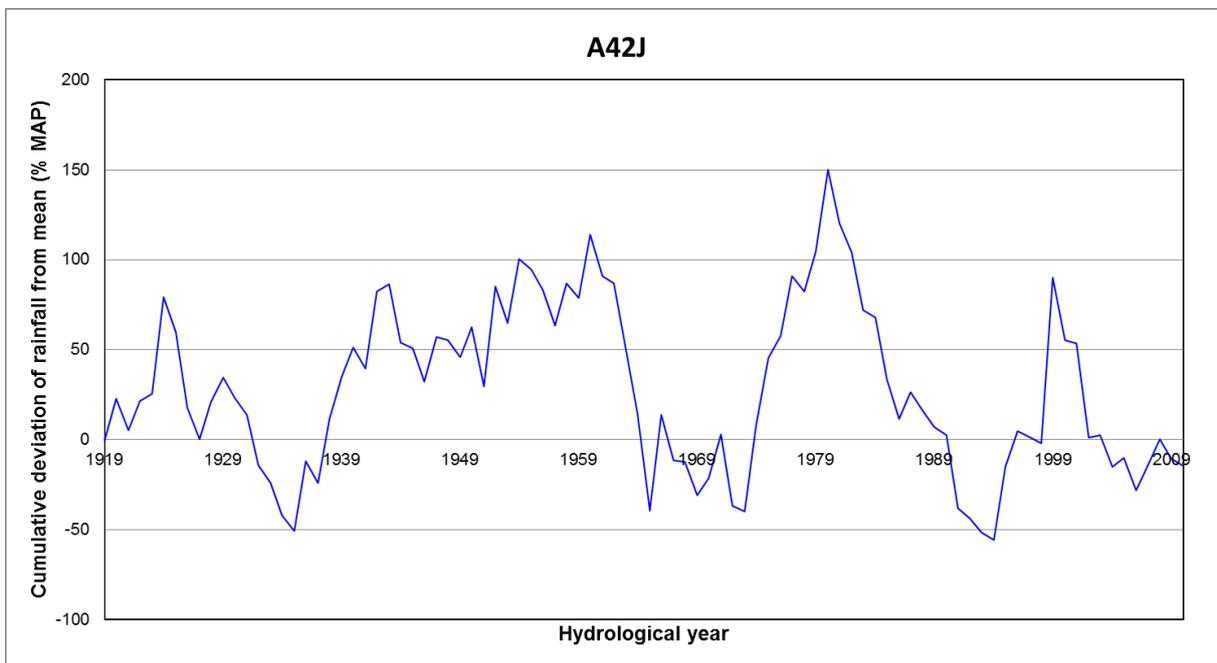


Figure E.22: A42J catchment rainfall cusum plot

Lephalala River Catchment

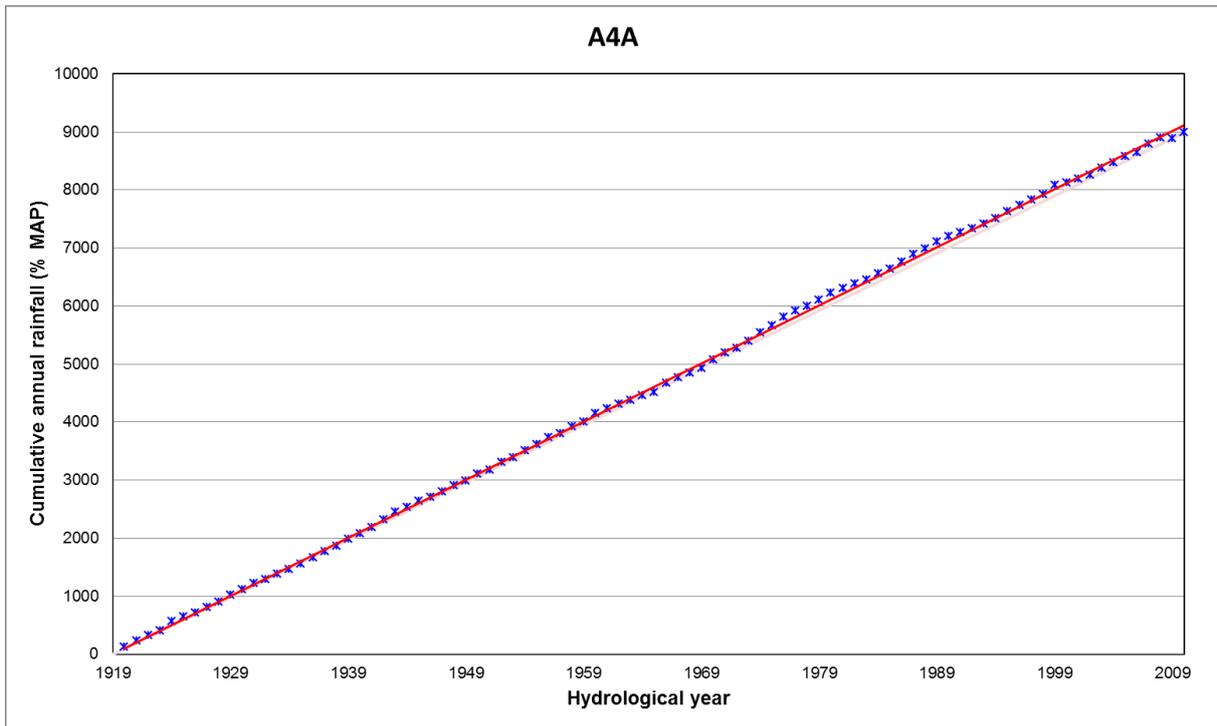


Figure E.23: A50A catchment rainfall single mass plot

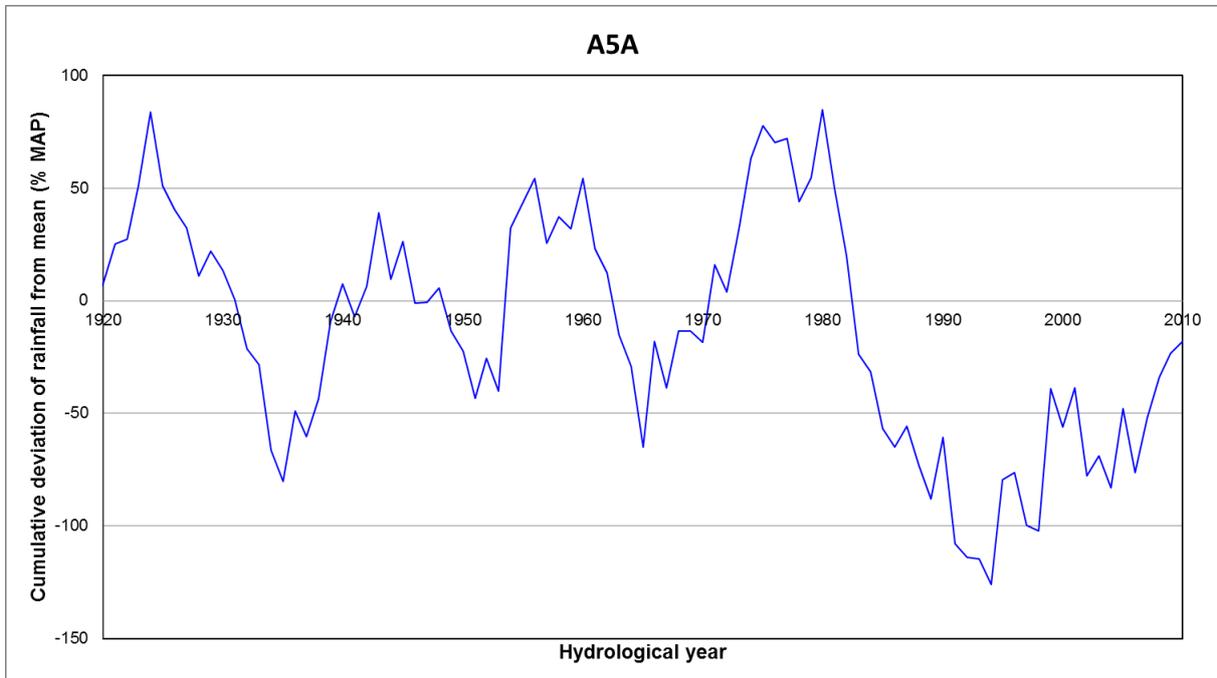


Figure E.24: A50A catchment rainfall cusum plot

Lephalala River Catchment

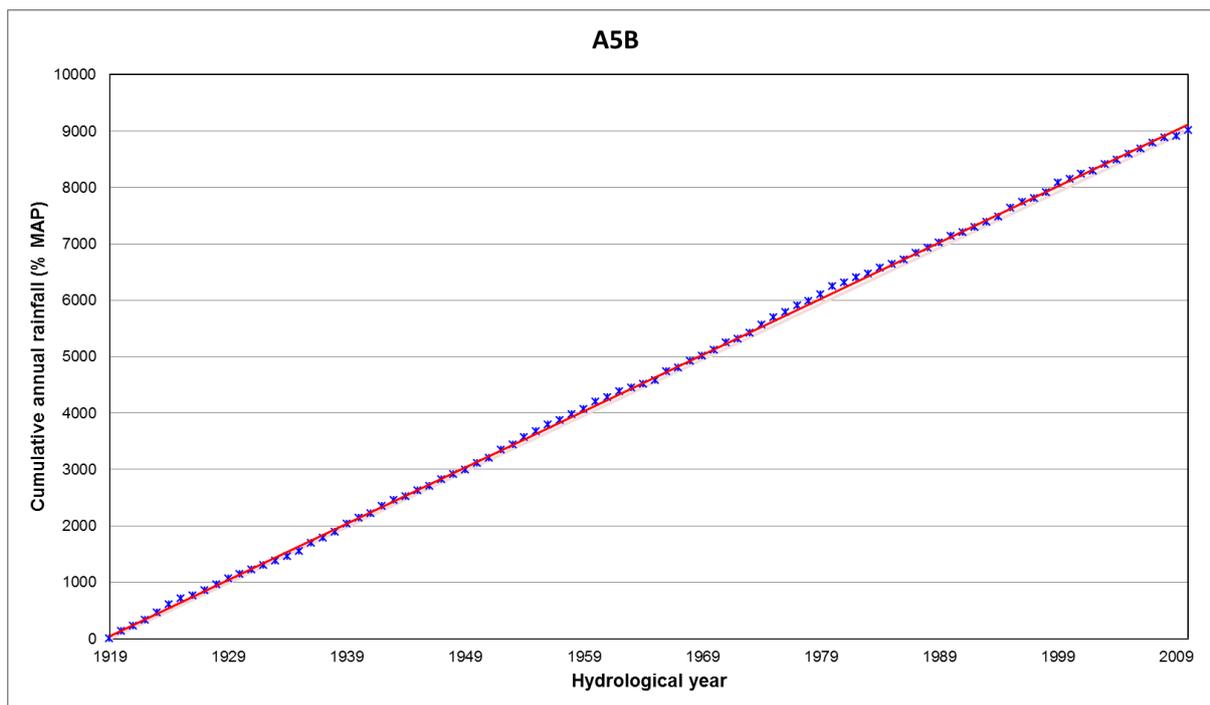


Figure E.25: A5B catchment rainfall single mass plot

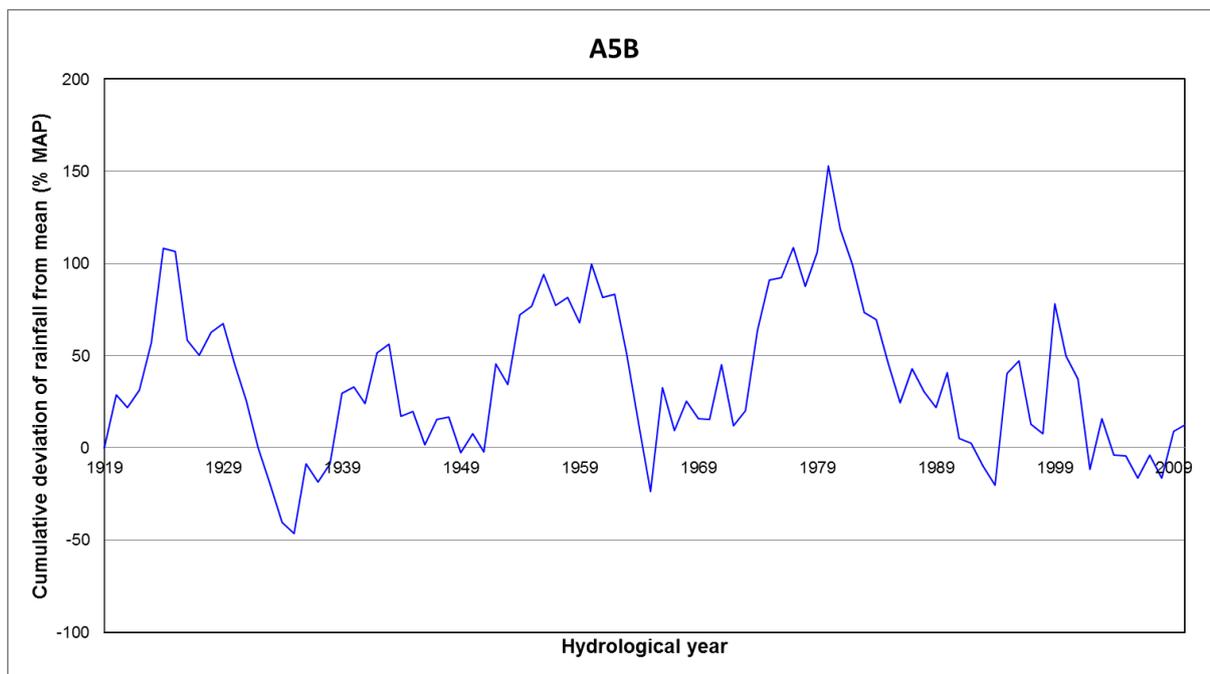


Figure E.26: A5B catchment rainfall cusum plot

Lephalala River Catchment

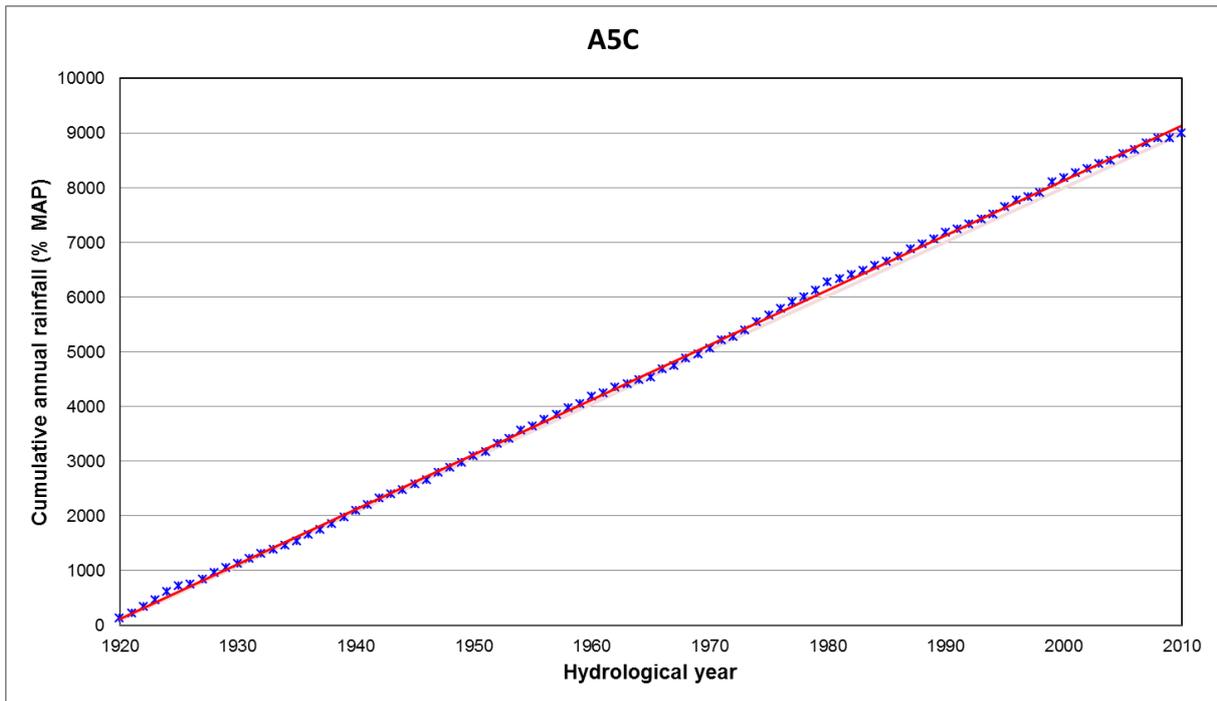


Figure E.27: A5C catchment rainfall single mass plot

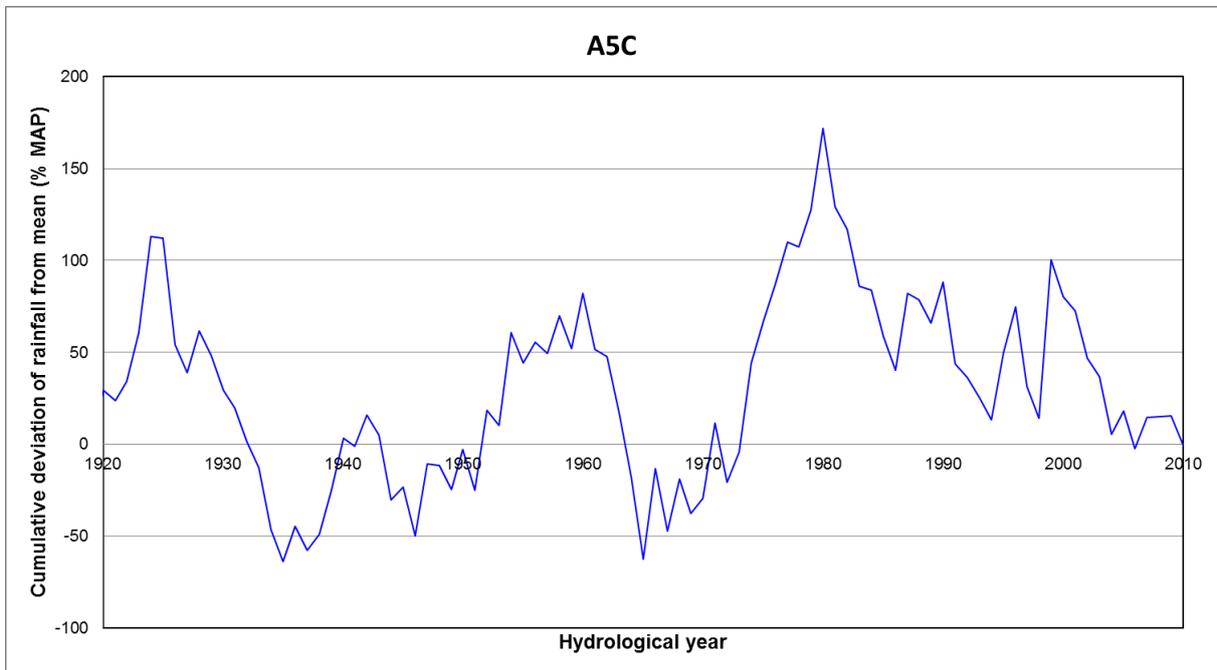


Figure E.28: A5C catchment rainfall cusum plot

Mogalakwena River Catchment

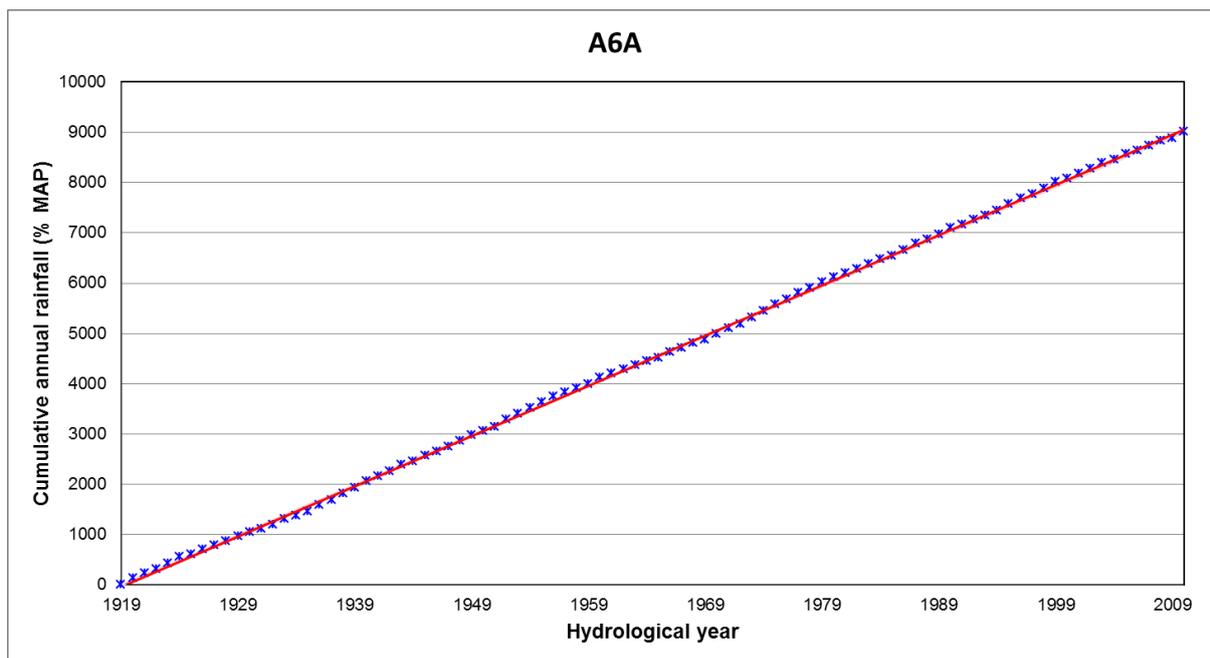


Figure E.29: A6A catchment rainfall single mass plot

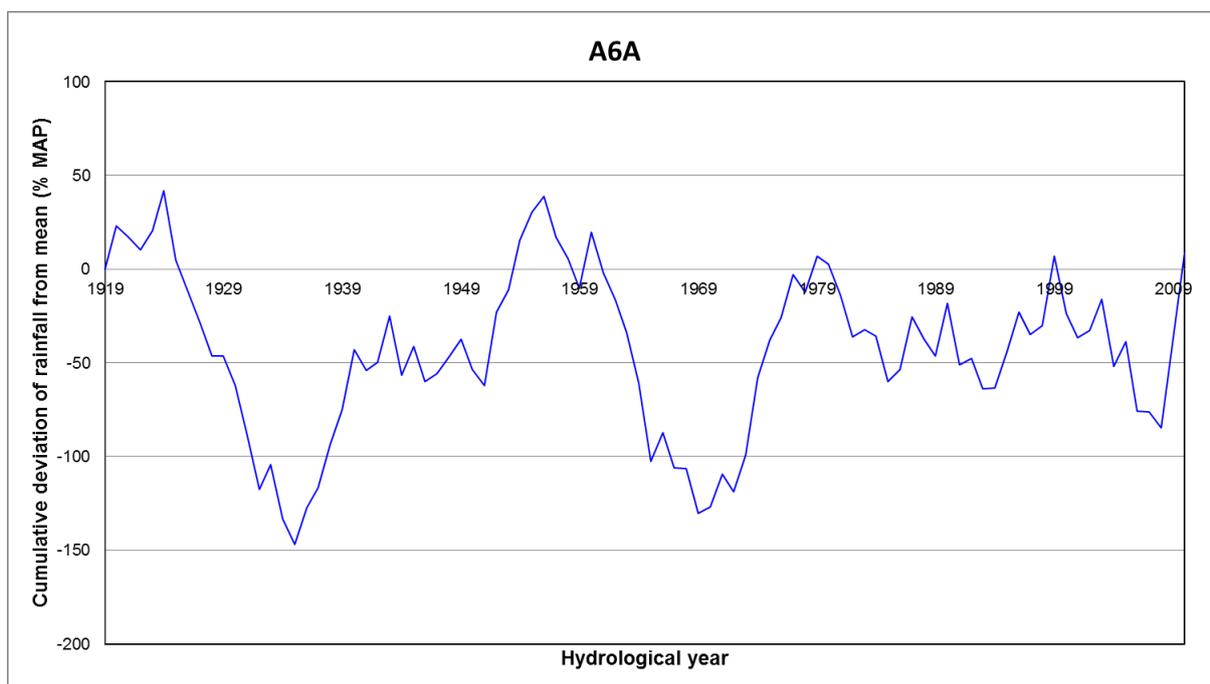


Figure E.30: A6A catchment rainfall cusum plot

Mogalakwena River Catchment

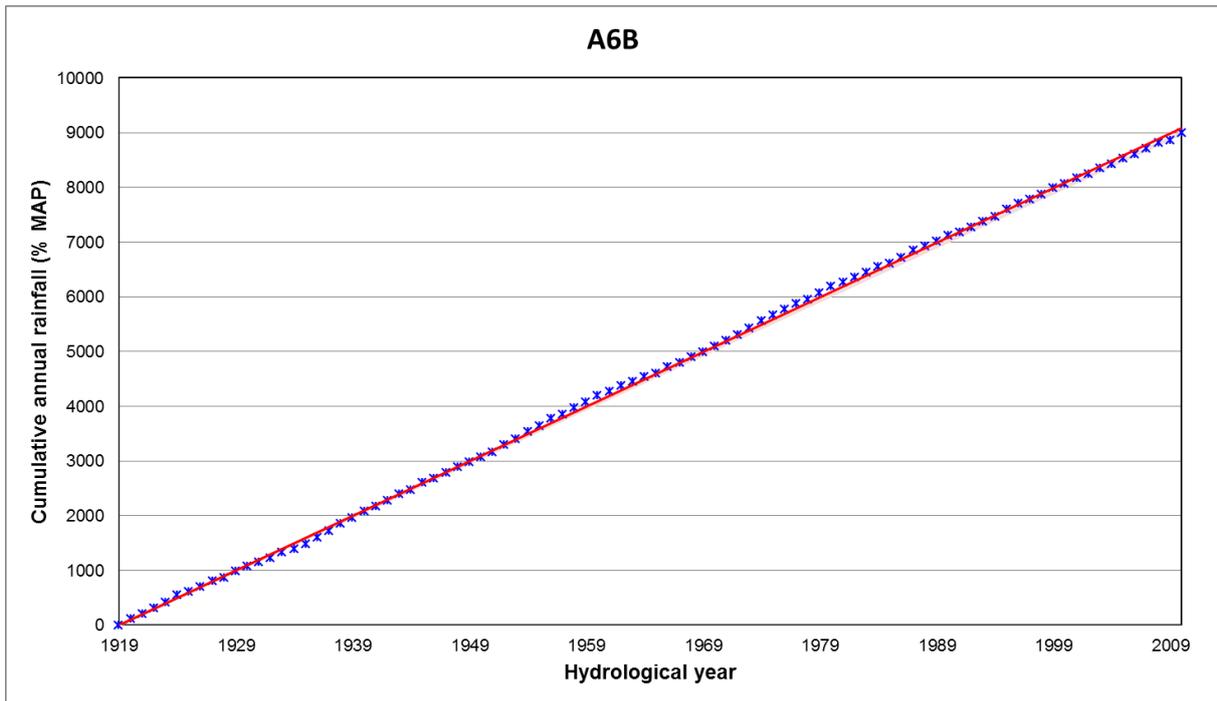


Figure E.31: A6B catchment rainfall single mass plot

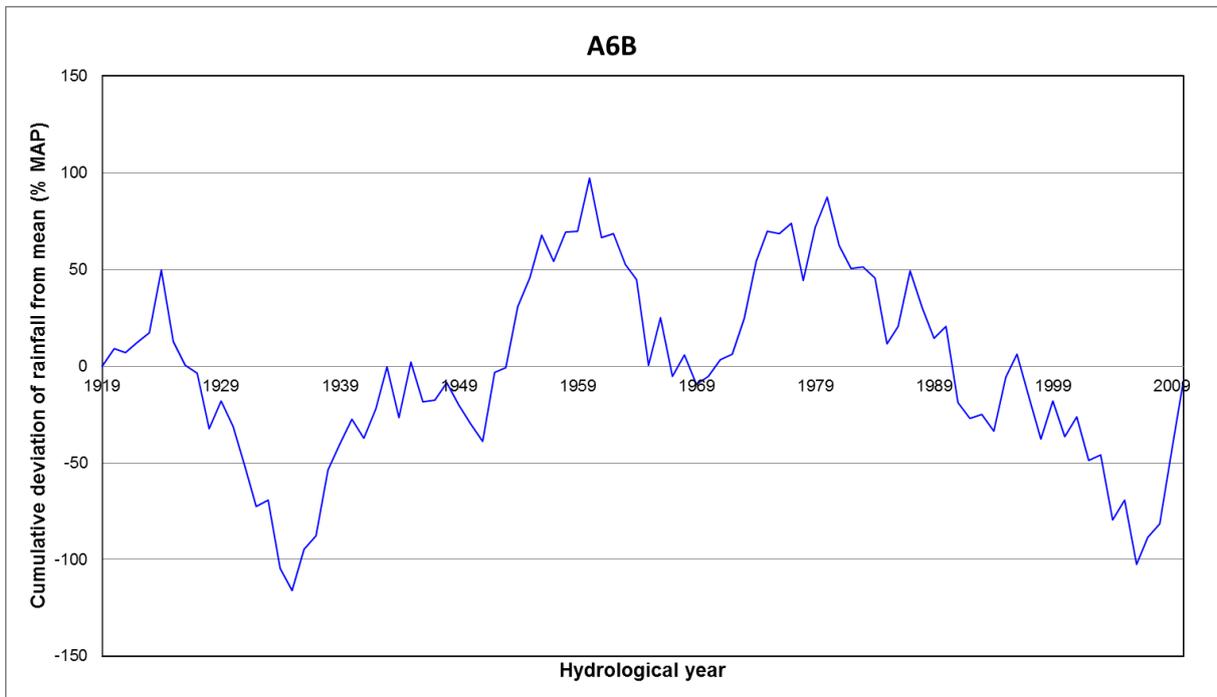


Figure E.32: A6B catchment rainfall cusum plot

Mogalakwena River Catchment

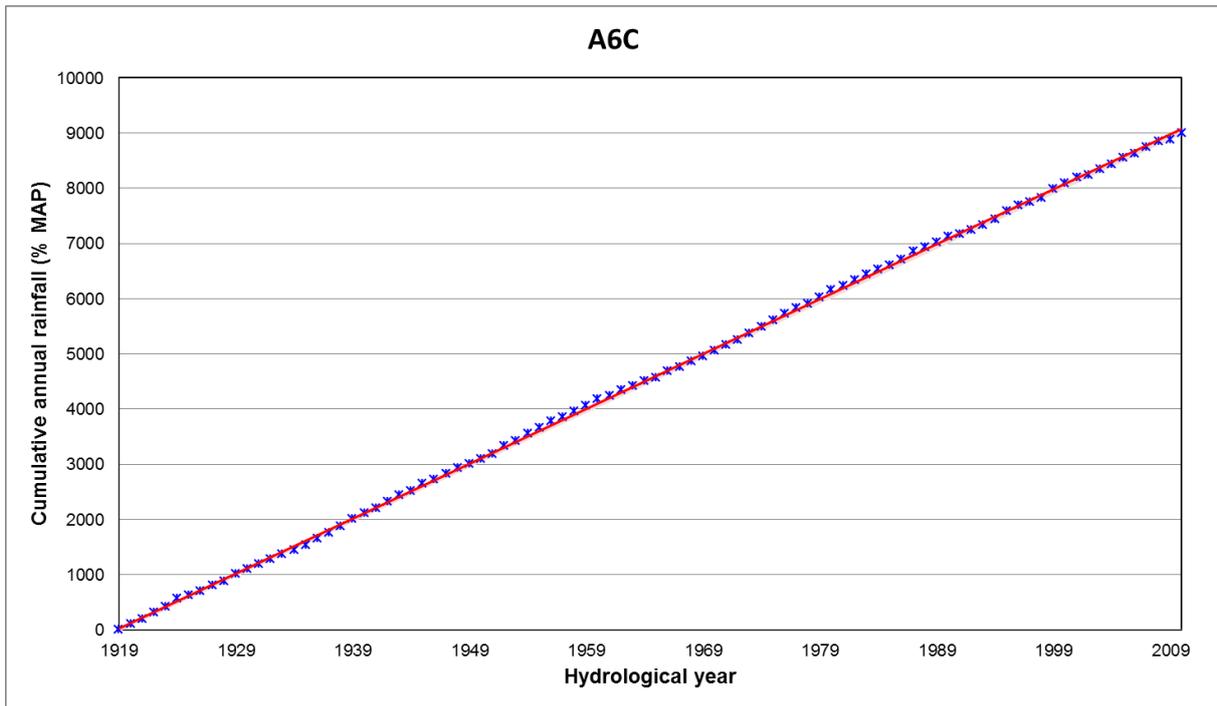


Figure E.33: A6C catchment rainfall single mass plot

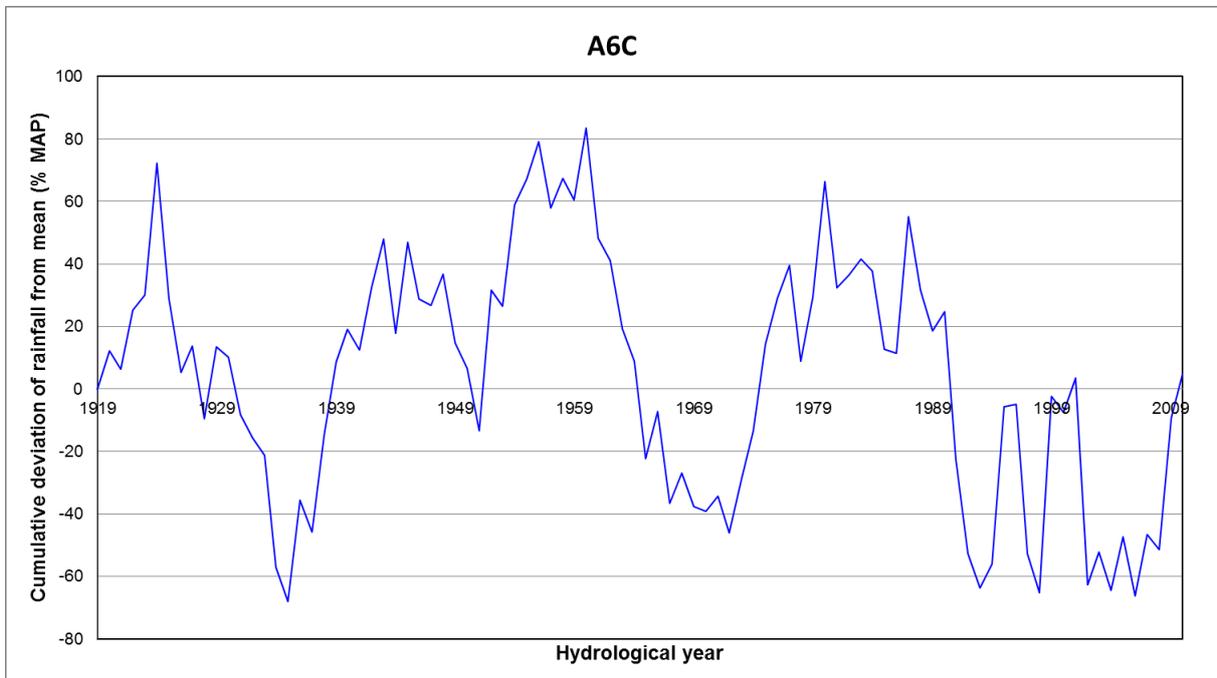


Figure E.34: A6C catchment rainfall cusum plot

Mogalakwena River Catchment

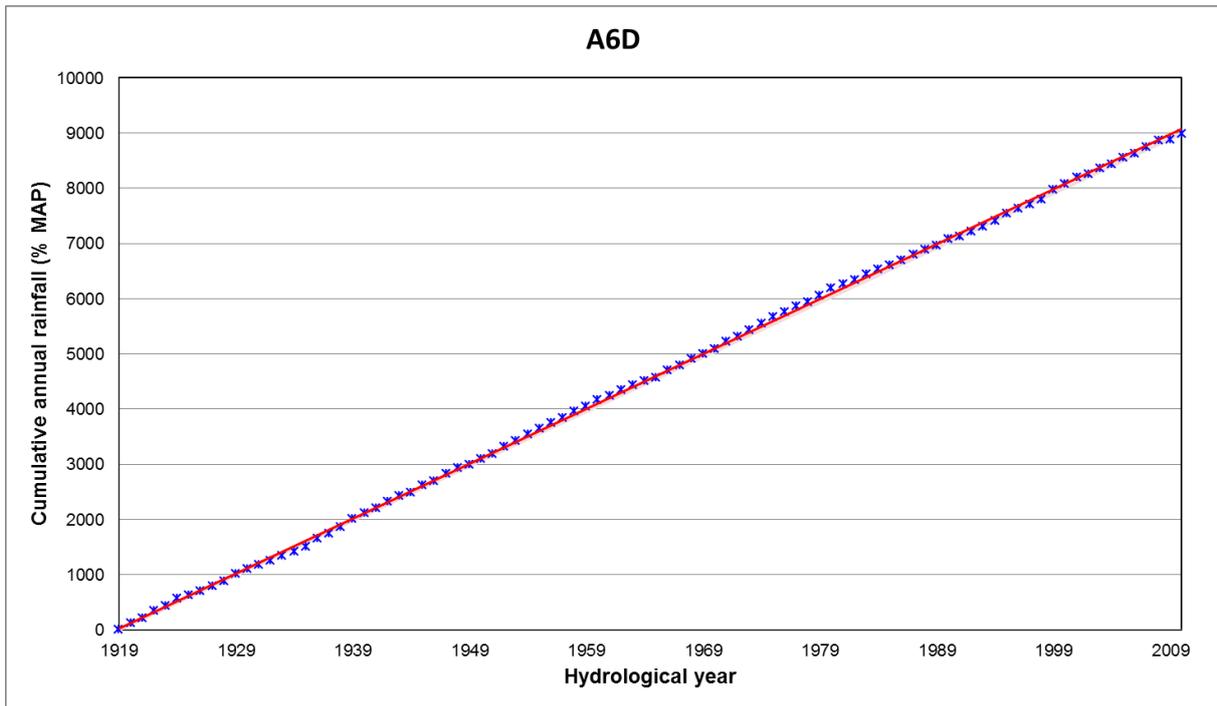


Figure E.35: A6D catchment rainfall single mass plot

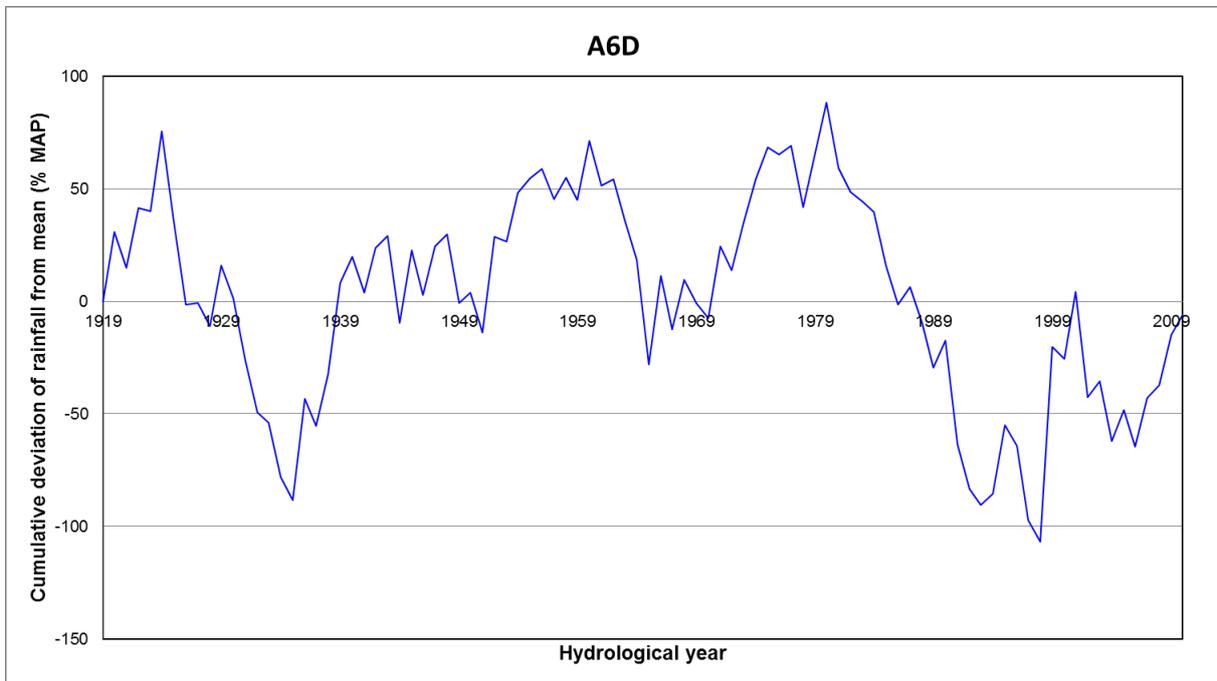


Figure E.36: A6D catchment rainfall cusum plot

Mogalakwena River Catchment

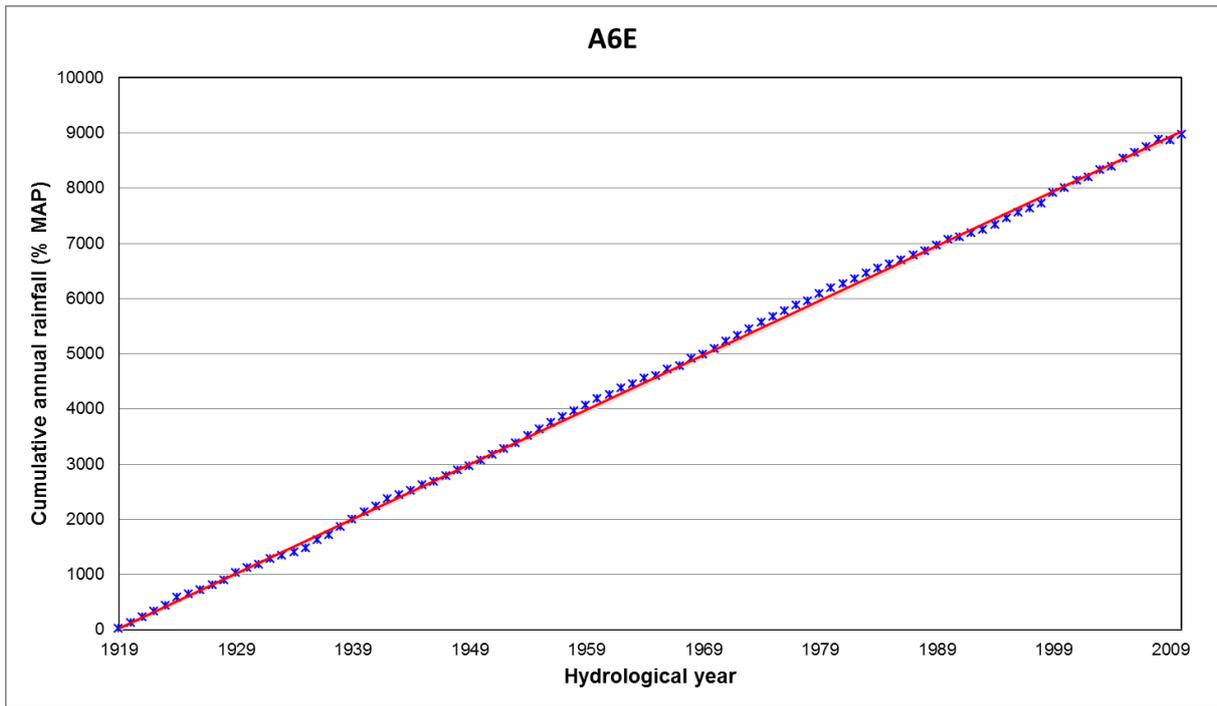


Figure E.37: A6E catchment rainfall single mass plot

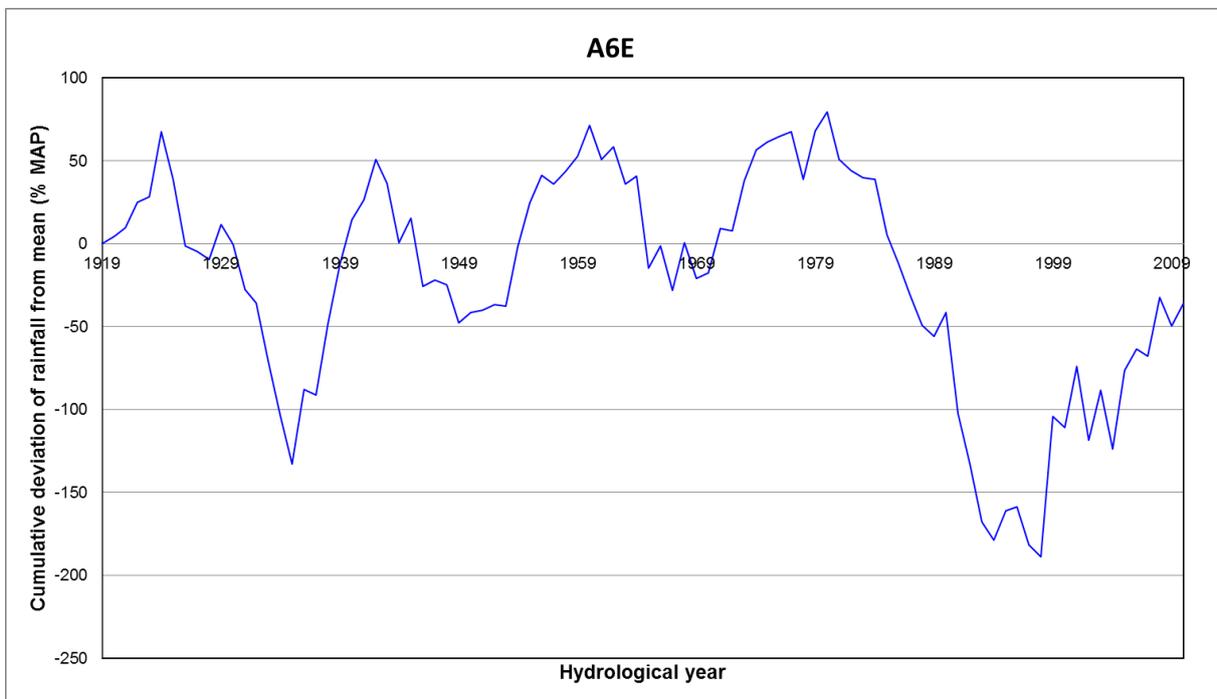


Figure E.38: A6E catchment rainfall cusum plot

Mogalakwena River Catchment

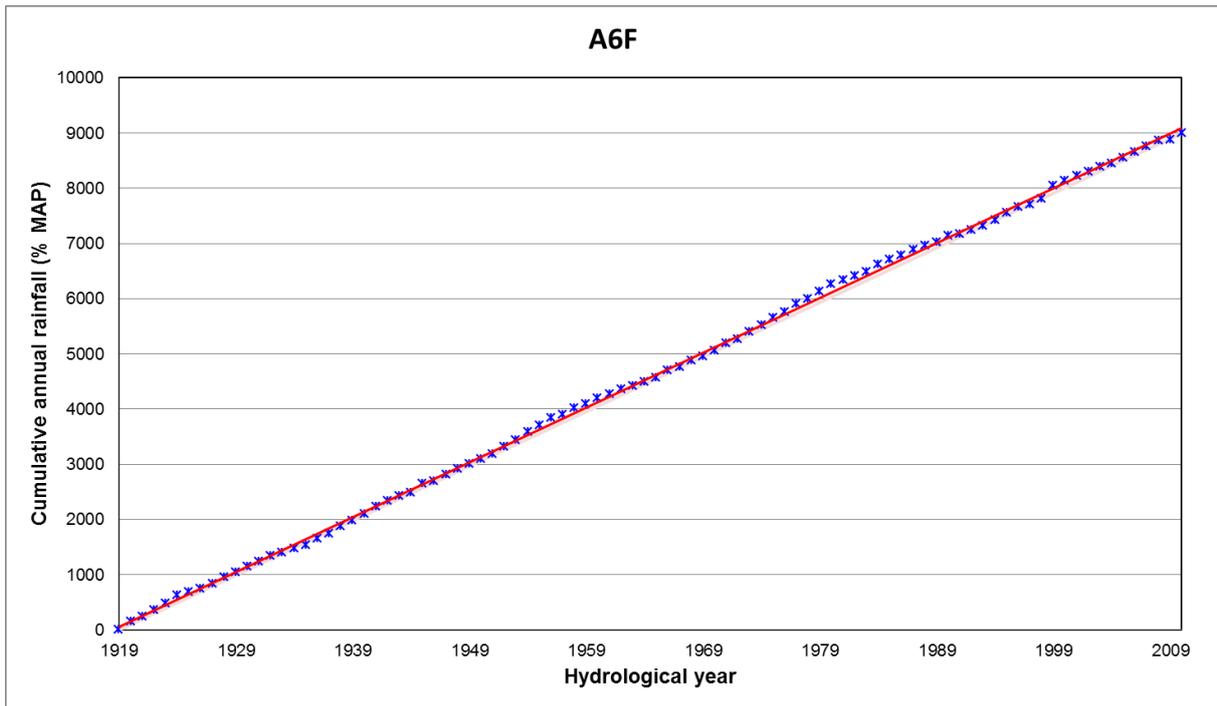


Figure E.39: A6F catchment rainfall single mass plot

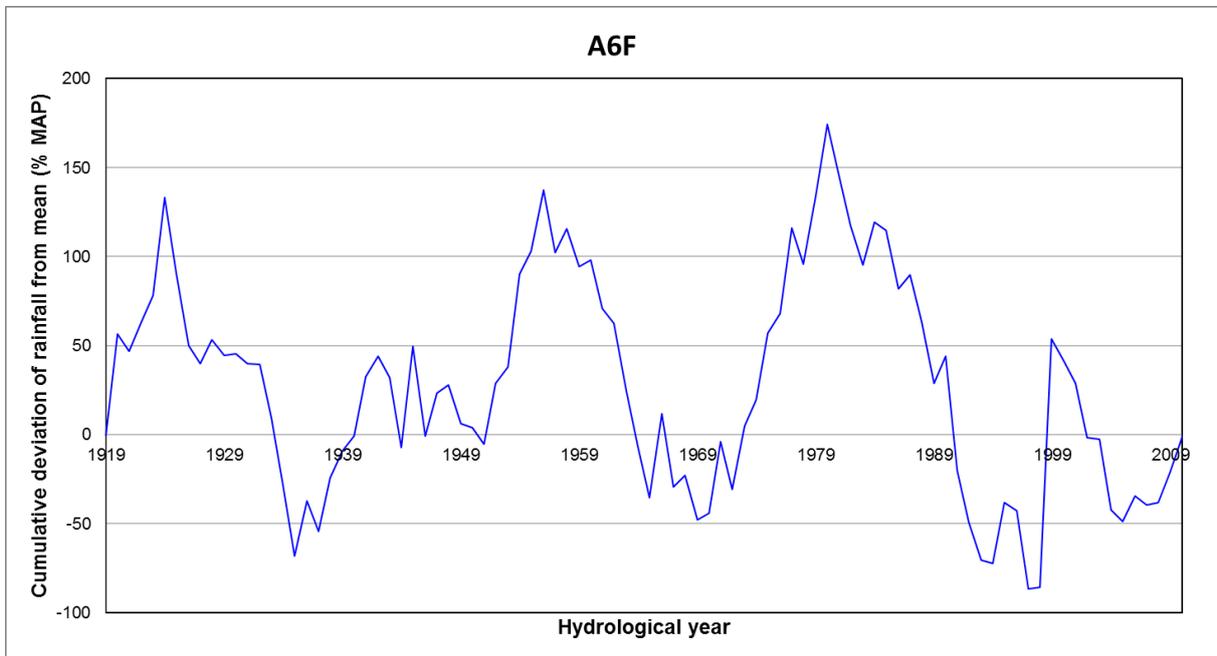


Figure E.40: A6F catchment rainfall cusum plot

Sand River Catchment

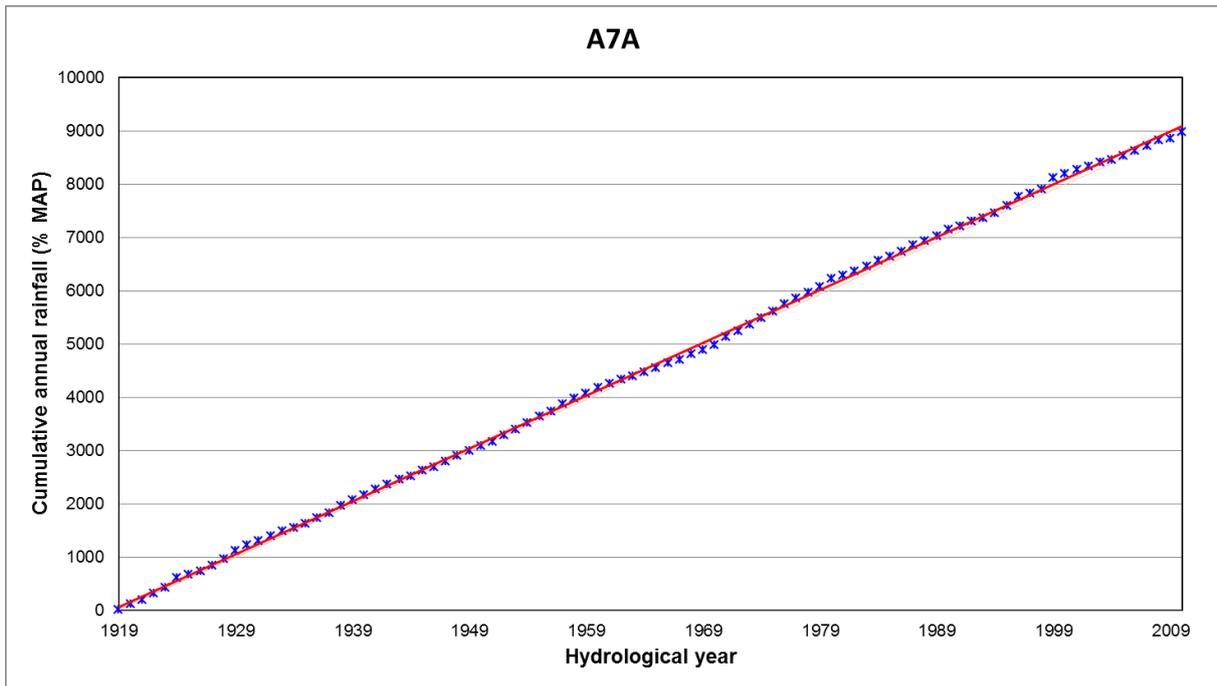


Figure E.41: A7A catchment rainfall single mass plot

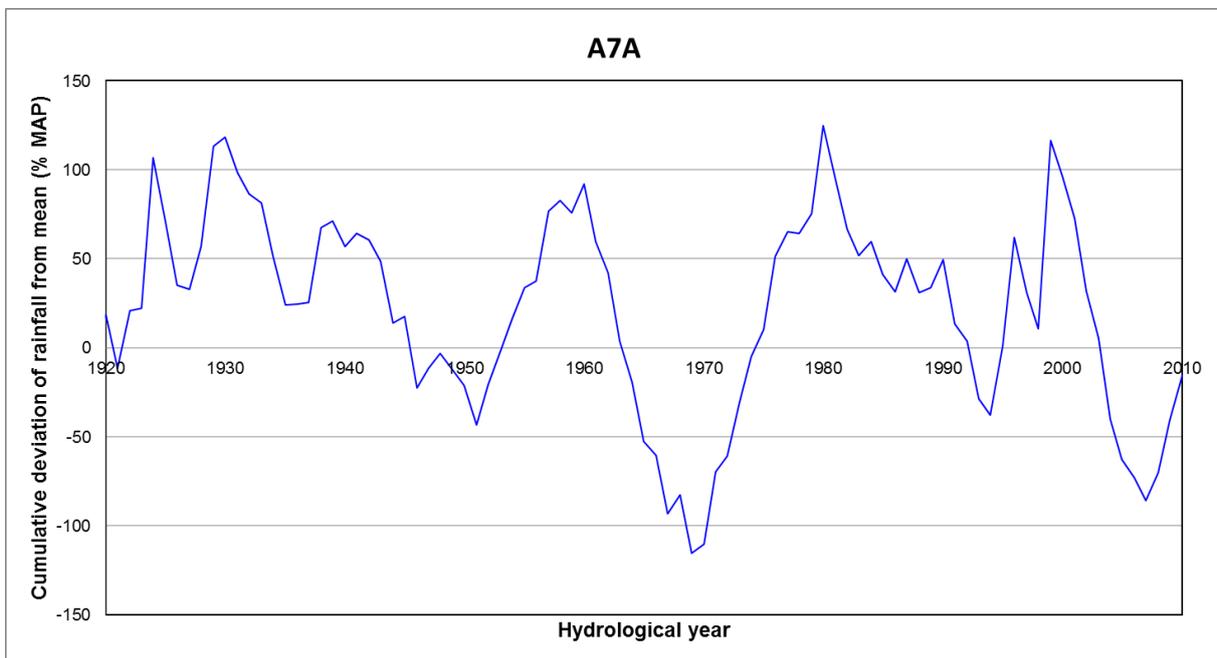


Figure E.42: A7A catchment rainfall cusum plot

Sand River Catchment

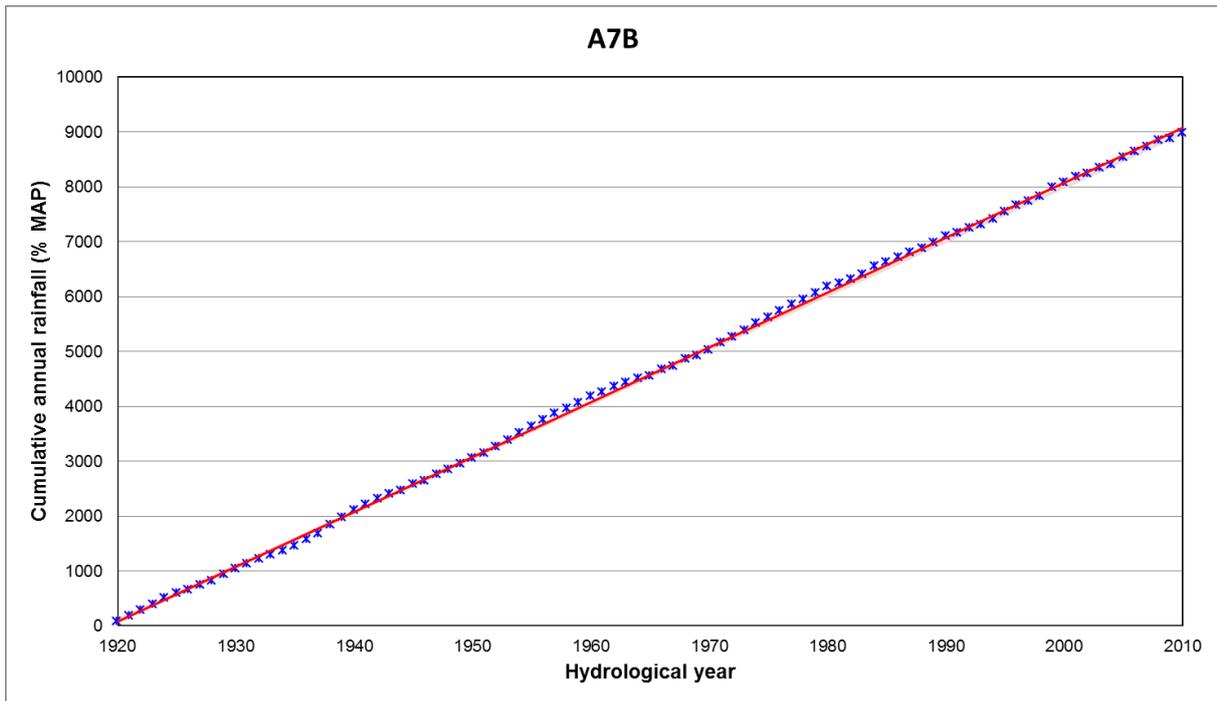


Figure E.43: A7B catchment rainfall single mass plot

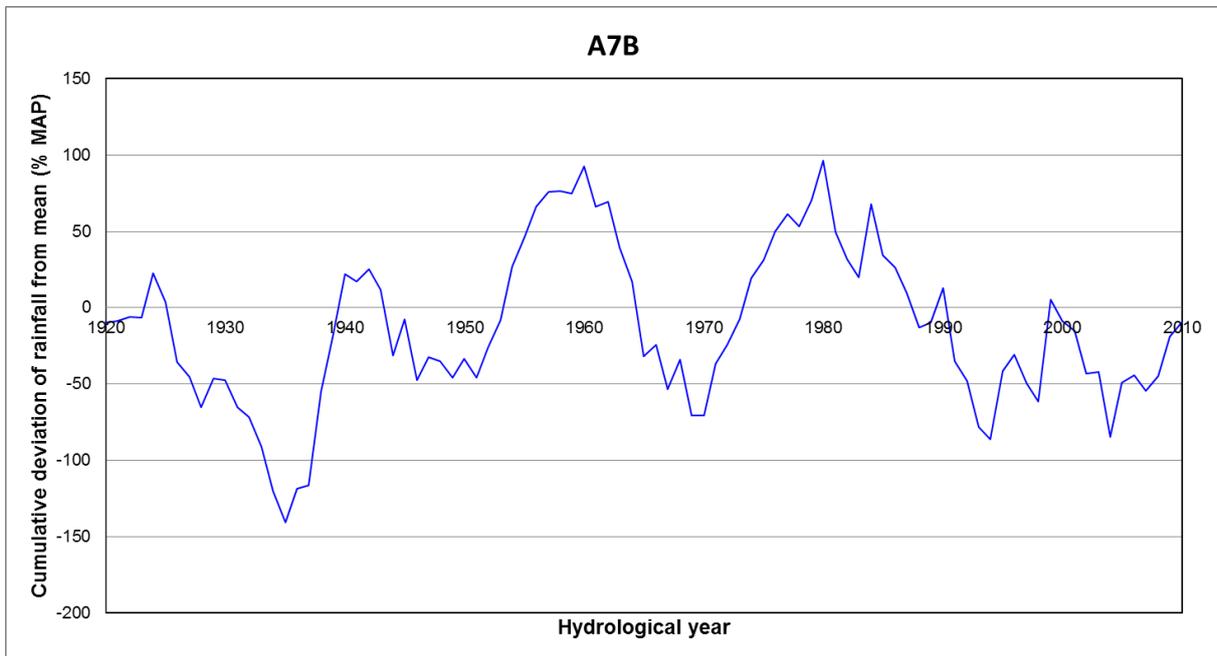


Figure E.44: A7B catchment rainfall cusum plot

Sand River Catchment

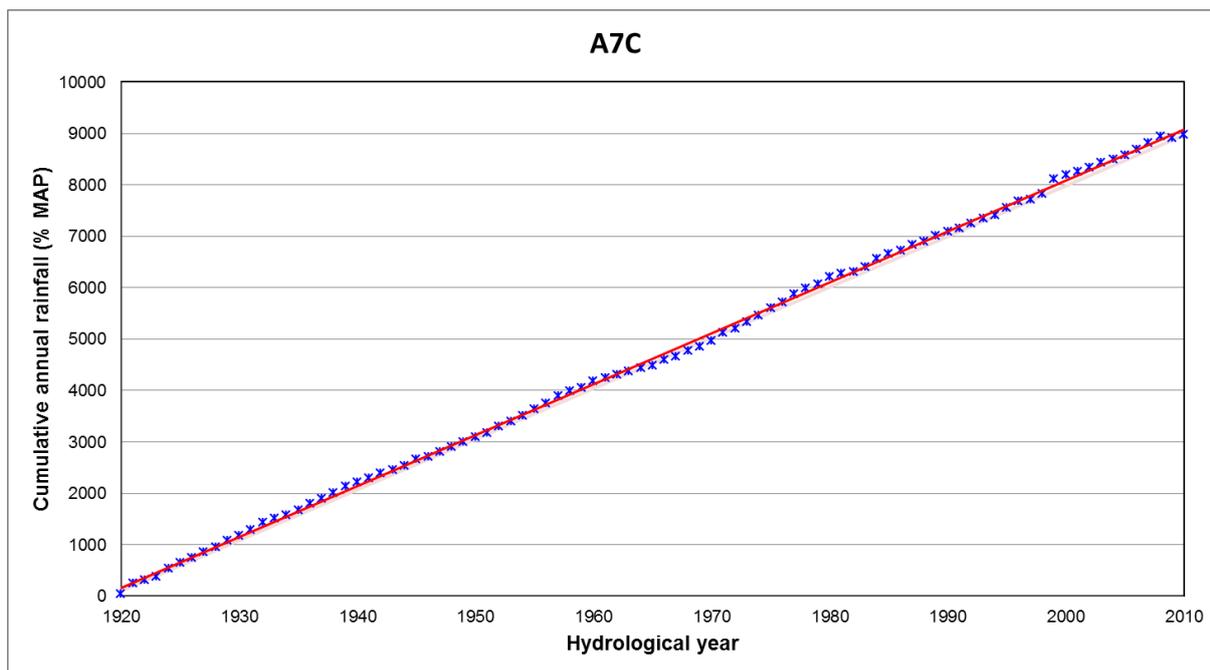


Figure E.45: A7C catchment rainfall single mass plot

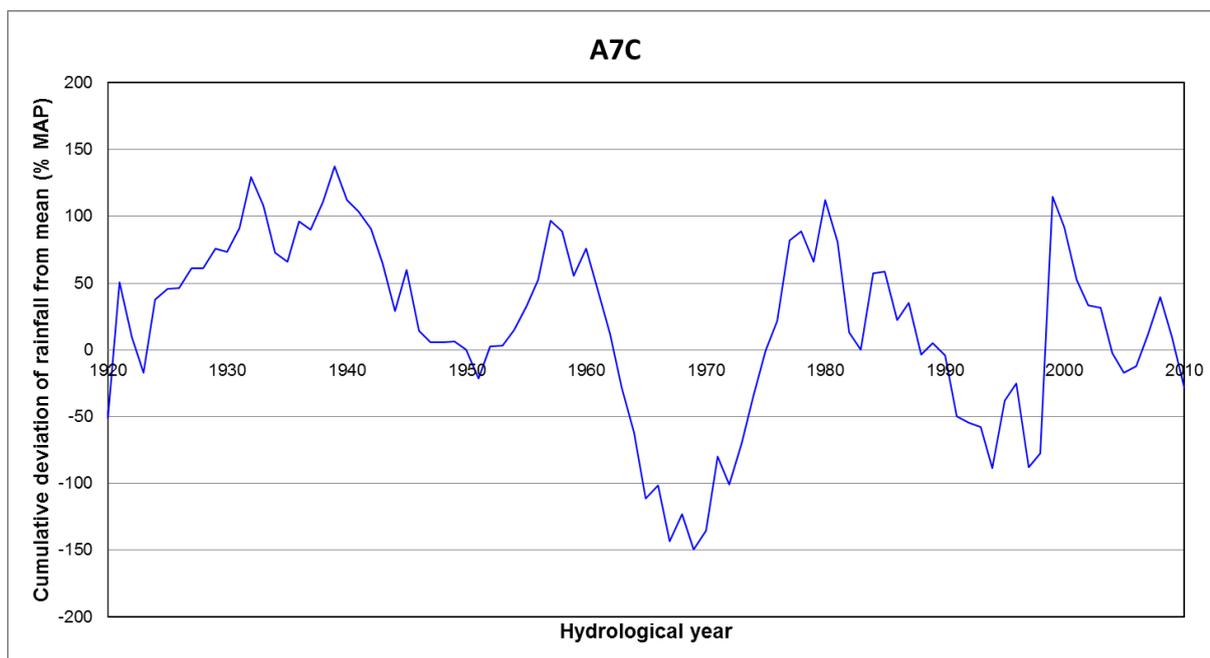


Figure E.46: A7C catchment rainfall cusum plot

Nzhelele River Catchment

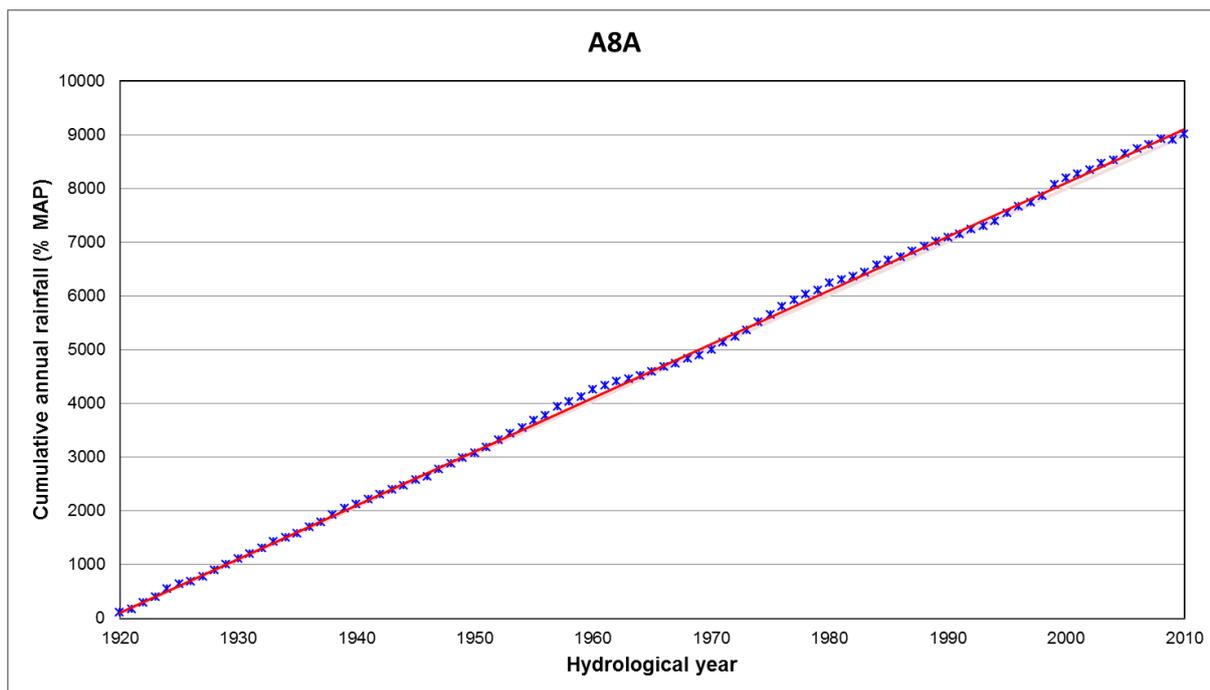


Figure E.47: A8A catchment rainfall single mass plot

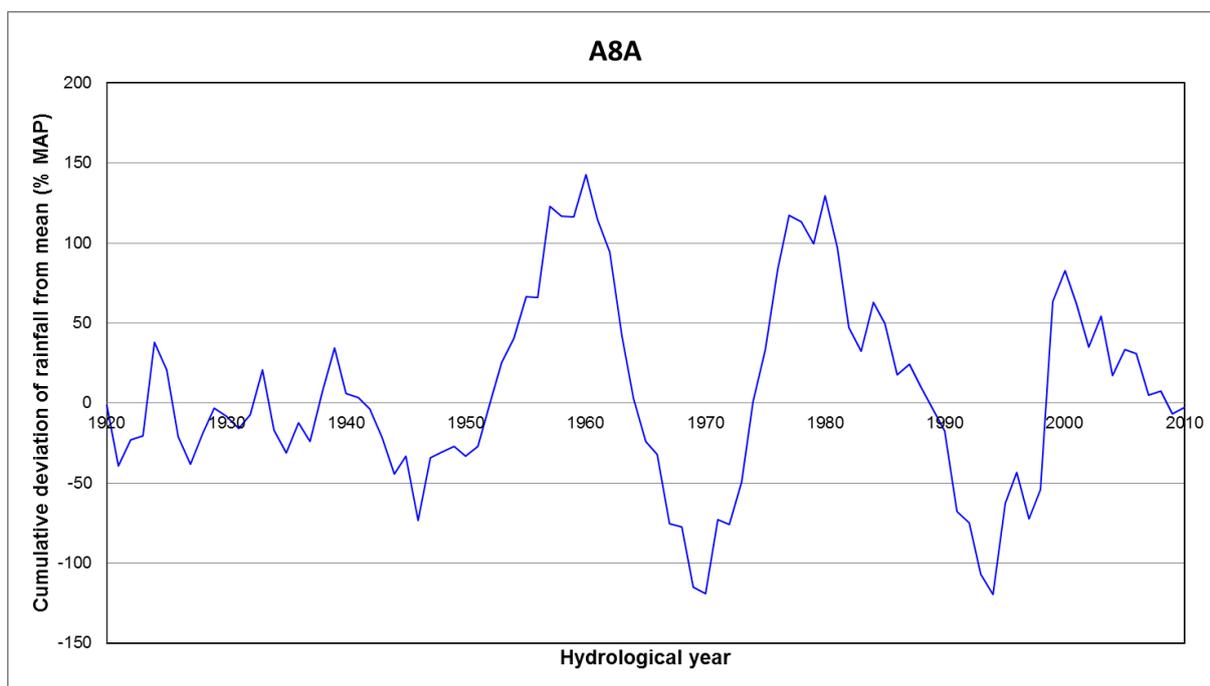


Figure E.48: A8A catchment rainfall cusum plot

Nzhelele River Catchment

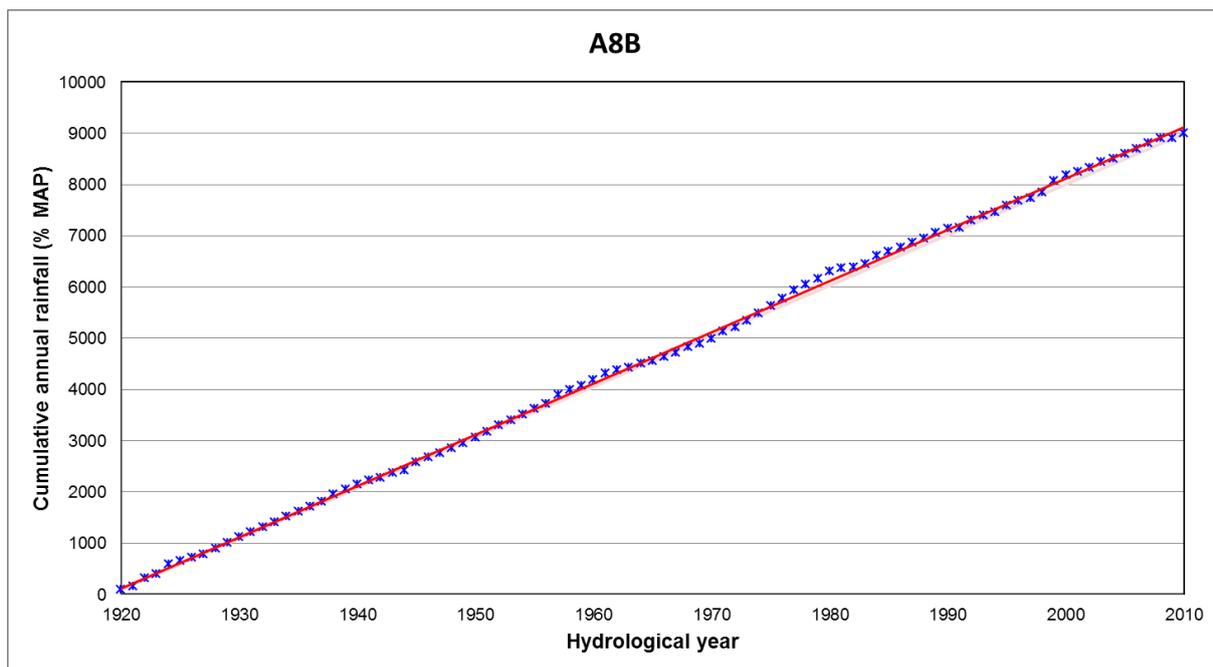


Figure E.49: A8B catchment rainfall single mass plot

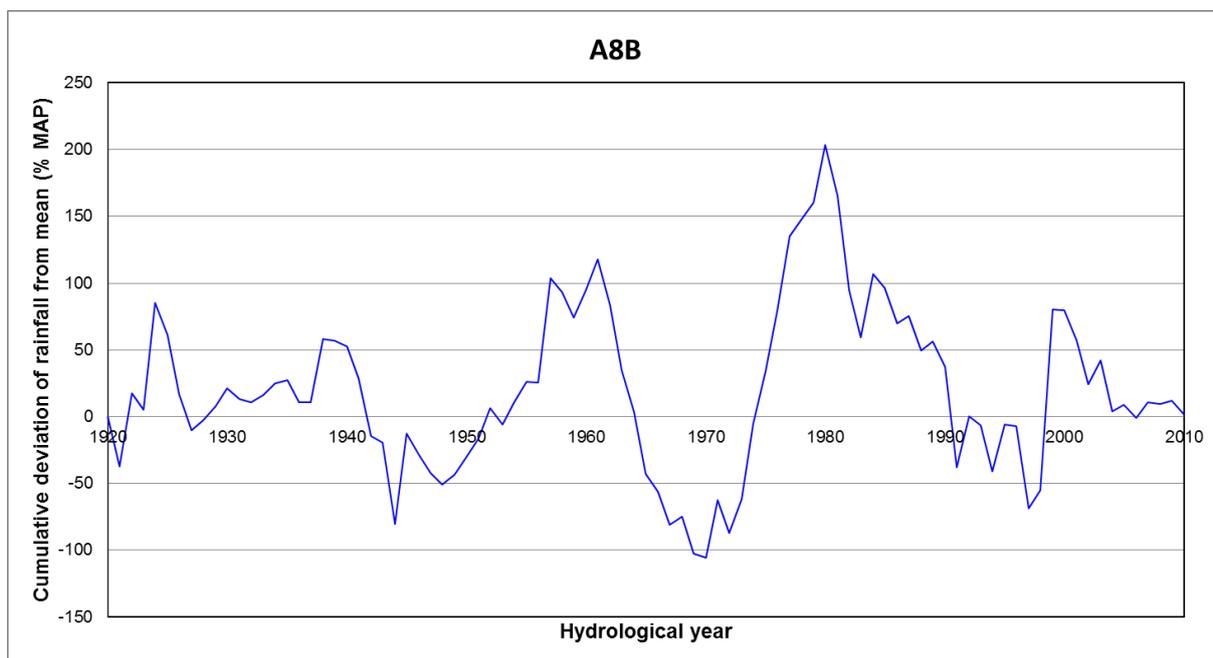


Figure E.50: A8B catchment rainfall cusum plot

Appendix F

Adjusted MAP values

Table F.1: Adjusted catchment MAPs

Catchment	Rainfall zone	Quaternary	WR90 MAP (mm)	1920-1989 average (%)	MAP factor	MAP (mm)
Matlabas	A4A	A41A	625	101.36	0.987	616.61
		A41B	587	101.36		579.12
	A4B	A41C	512	100.36	0.996	510.16
		A41D	492	100.36		490.24
		A41E	438	100.36		436.43
Mokolo	A4C	A42A	640	99.53	1.005	643.02
		A42B	660	99.75	1.003	661.65
		A42C	656	99.70	1.003	657.97
	A4D	A42D	667	99.63	1.004	669.48
		A42E	605	101.36	0.987	596.88
		A42F	577	101.24	0.988	569.93
	A4E	A42G	551	101.19	0.988	544.52
		A42H	518	100.32	0.997	516.35
		A42J	428	100.10	0.999	427.57
	Lephalala	A5A	A50A	654	98.74	1.013
A50B			599	98.74	606.64	
A50C			593	98.74	600.57	
A5B		A50D	558	100.31	0.997	556.28
		A50E	517	100.31		515.40
		A50F	496	100.31		494.47
A5C		A50G	435	100.94	0.991	430.95
		A50H	407	100.94		403.21
		A50J	391	100.94		387.36
Mogalakwena	A6A	A61A	629	99.33	1.007	633.24
		A61B	625	99.33		629.22
		A61C	608	99.33		611.83
	A6B	A61D	630	100.21	0.998	628.68
		A61E	615	100.21		613.71
		A61H	636	100.21		634.67
	A6C	A61F	597	100.26	0.997	595.45
		A61G	585	100.26		583.48
		A61J	631	100.26		629.36
	A6D	A62A	610	99.58	1.004	612.57
		A62B	529	99.58		531.23
		A62C	478	99.58		480.02
		A62D	489	99.58		491.06
	A6E	A62E	460	99.20	1.008	463.71
A62F		478	99.20	481.85		

Catchment	Rainfall zone	Quaternary	WR90 MAP (mm)	1920-1989 average (%)	MAP factor	MAP (mm)	
		A62G	437	99.20		440.52	
		A62H	439	99.20		442.54	
		A62J	450	99.20		453.63	
	A6F	A63A	433	100.41	0.996	431.23	
		A63B	394	100.41		392.39	
		A63C	378	100.41		376.46	
		A63D	412	100.41		410.32	
		A63E	358	100.41		356.54	
	Sand	A7A	A71A	468	100.48	0.995	465.76
			A71B	450	100.48		447.85
A71C			418	100.48	416.00		
A71D			390	100.48	388.14		
A71H			491	100.48	488.65		
A7B		A71E	421	99.86	1.001	421.59	
		A71F	400	99.86		400.56	
		A71G	427	99.86		427.60	
		A72A	465	99.86		465.65	
A7C		A71J	396	100.07	0.999	395.72	
		A71K	305	100.07		304.79	
		A71L	288	100.07		287.80	
		A72B	344	100.07		343.76	
Nzhelele		A8A	A80A	938	99.94	1.001	938.56
	A80B		659	99.94	659.40		
	A80C		576	99.94	576.35		
	A80D		622	99.94	622.37		
	A80E		622	99.94	622.37		
	A80F		388	99.94	388.23		
	A8B	A80G	333	100.81	0.992	330.32	
		A80H	621	100.81		616.01	
		A80J	292	100.81		289.65	