

## **Trends in Extreme Climate Indices in South Africa 2019**

## **Executive Summary**

- The South African Weather Service (SAWS) provides updates of the WMO Extreme Climate Indices on an annual basis.
- The indices provide a general impression of the trend in weather and climate extremes in South Africa, with the latest index values included in the report for comparative purposes.
- A set of 27 core indices were developed By the WMO to track extremes in surface temperature and precipitation. However, not all of the indices are relevant to the South African climate. In this regard a subset of 10 surface temperature and 11 precipitation indices were selected for reporting purposes.
- The data sets analysed consist of a set of 26 homogenised temperature time series for the period around 1931 – 2019 and 70 rainfall time series from the 1920's to 2019.
- A summary is included on p.52, highlighting the inferences/conclusions that can be drawn from the results.

## Table of Contents

<b>Executive Summary</b>	<b>2</b>
<b>Table of Contents</b>	<b>3</b>
<b>1. Introduction</b>	<b>4</b>
<b>2. Data</b>	<b>4</b>
<b>3. Methodology</b>	<b>8</b>
<b>4. Results per individual station</b>	<b>9</b>
<b>4.1 Surface Temperature</b>	<b>9</b>
<b>4.2 Rainfall</b>	<b>17</b>
<b>5. Maps of Extreme Index trends</b>	<b>41</b>
<b>5.1 Surface temperature</b>	<b>41</b>
<b>5.2 Rainfall</b>	<b>46</b>
<b>6. Summary</b>	<b>52</b>
<b>7. References</b>	<b>53</b>

## 1. Introduction

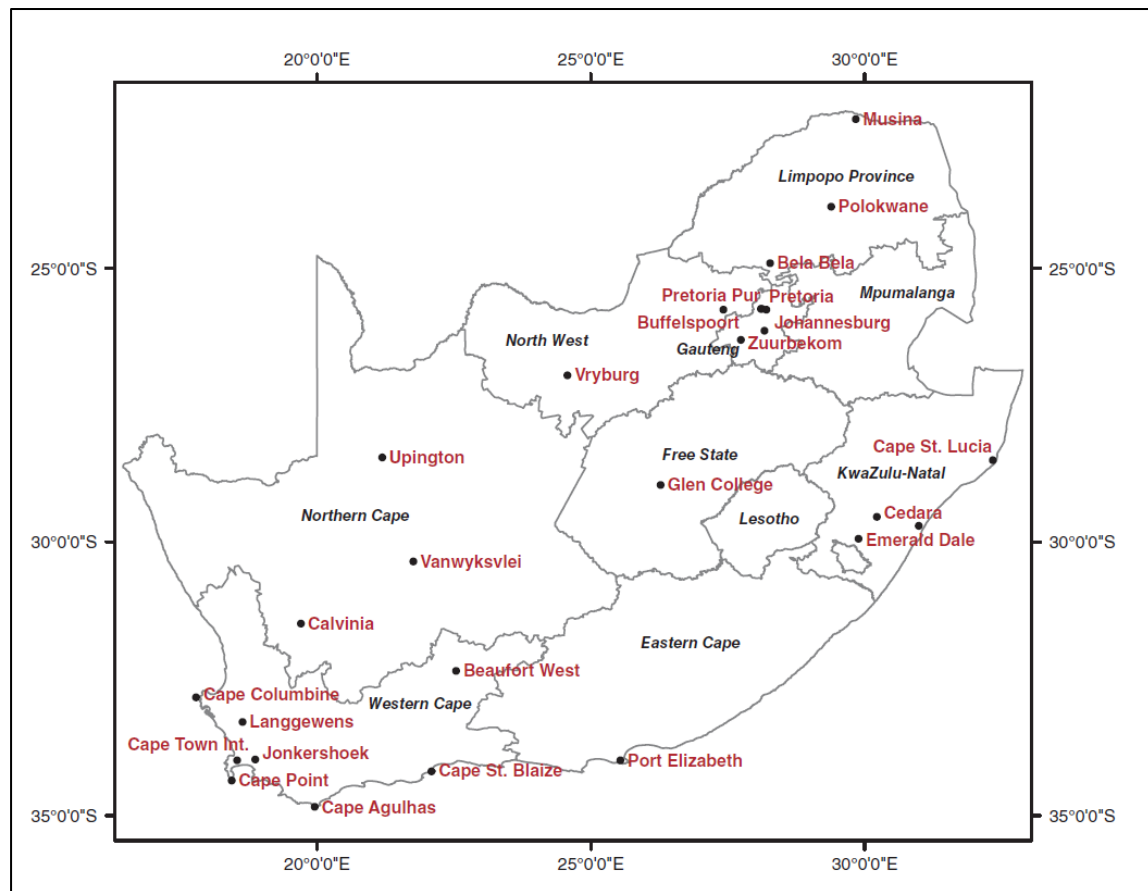
The World Meteorological Organization (WMO) Expert Team on Climate Change Detection and Indices (ETCCDI) has developed a set of 27 core indices which is used globally to detect trends in relevant climate extremes (Donat et al., 2013). The South African Weather Service (SAWS) has previously used these indices to analyse historical trends in rainfall and temperature extremes in South Africa, contributing to the Donat et al. (2013) study, as well as subsequent updates (Kruger and Nxumalo, 2016; 2017). The results were also included in the South African Third National Communication on Climate Change, which provided a general overview of the historical trends in the climate, including climate extremes. As interest in the indices grew, it was decided that the WMO ETCCDI indices be updated on an annual basis.

## 2. Data

The Kruger and Nxumalo (2016, 2017) papers provide the information on the data that will be utilised for the index updates. For surface temperature the data of 26 homogenised temperature series will be used. The table below provide the details of these stations and the subsequent map the positions of the stations. From the map it can be seen that the stations can be deemed to be adequately distributed across the spatial domain of South Africa, with the number of station exceeding the minimum required to provide an adequate impression of climate trends over the country.

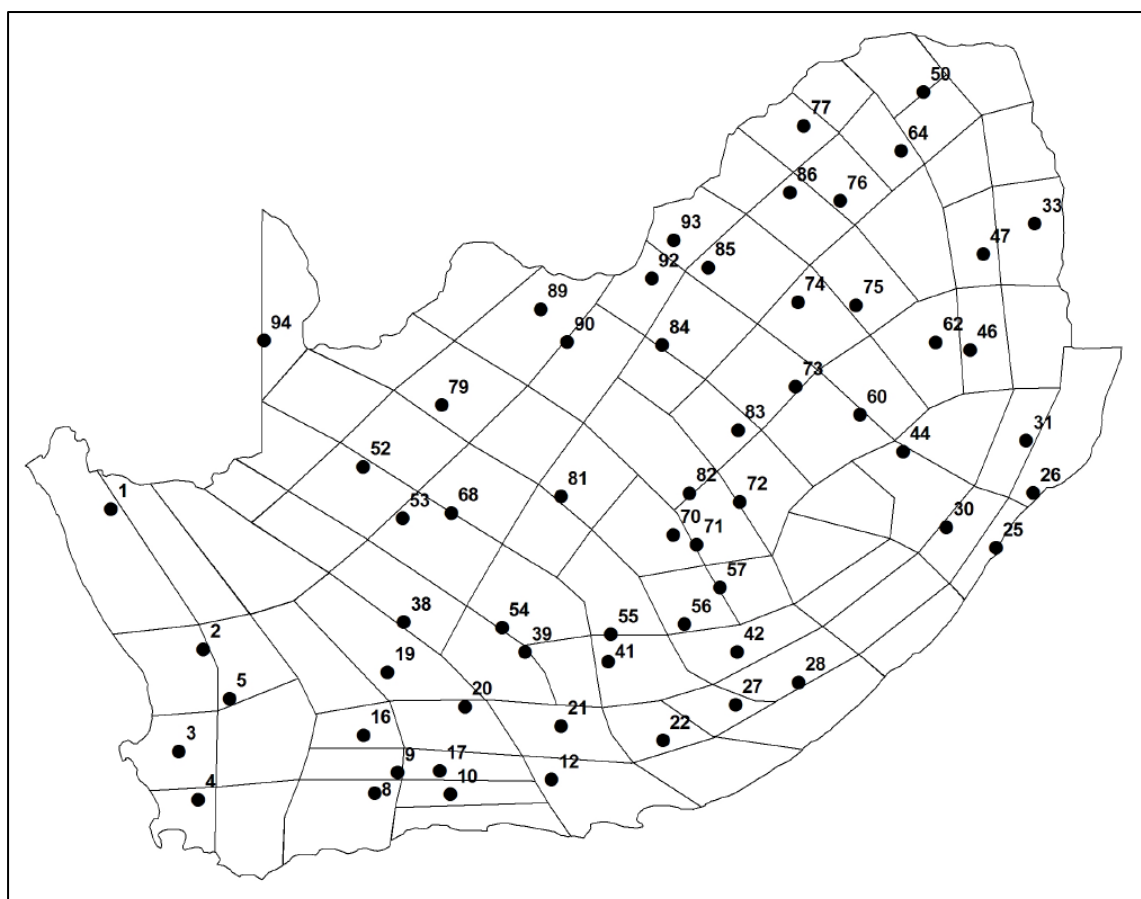
**Table 1.** Basis set of stations used for the surface temperature extreme index analysis (from Kruger and Nxumalo, 2016) (Note: Not all stations in the list are used in this report due to unavailability of recent data).

Station	No. of time series	No. of inhomogeneities		Approx. latitude (°)	Approx. longitude (°)	Approx. height (m)	Start year (after which 90% years available)
		Tx	Tn				
Cape Agulhas	1	2	0	-34.83	20.02	8	1931
Cape Point	1	0	0	-34.35	18.50	208–227	1931
Cape St. Blaize	4	4	3	-34.18	22.15	60–76	1931
Cape Town International	5	0	6	-33.98	18.60	42–46	1939
Jonkershoek	2	3	2	-33.97	18.93	244–350	1936
Port Elizabeth	2	1	1	-33.98	25.60	59–60	1937
Langgewens	1	1	2	-33.28	18.70	175	1931
Cape Columbine	1	6	0	-32.83	17.85	63	1936
Beaufort West	7	2	3	-32.35	22.60	857–902	1939
Calvinia	2	0	0	-31.48	19.77	975–980	1941
Vanwyksvlei	2	4	2	-30.35	21.82	962	1939
Emerald Dale	1	3	3	-29.93	29.95	1189	1931
Cedara	1	0	3	-29.53	30.28	1076	1931
Mount Edgecombe	1	4	0	-29.70	31.05	91	1931
Glen College	2	1	0	-28.95	26.33	1304	1932
Upington	4	0	0	-28.45	21.25	793–841	1943
Cape St. Lucia	4	4	2	-28.50	32.40	3–107	1947
Vryburg	1	0	0	-26.95	24.63	1234	1931
Zuurbekom	2	1	0	-26.30	27.80	1578	1931
Johannesburg International	4	4	4	-26.13	28.23	1676–1695	1946
Buffelspoort	1	1	4	-25.75	27.48	1230	1938
Pretoria PUR	1	0	0	-25.73	28.17	1286	1937
Pretoria	4	2	2	-25.73	28.18	1300–1330	1939
Pretoria University	2	4	5	-25.75	28.27	1372	1931
Experimental Farm							
Bela Bela	1	1	4	-24.90	28.33	1143	1937
Polokwane	5	0	0	-23.87	29.45	1230–1311	1939
Musina	2	3	1	-22.27	29.90	525	1933



**Figure 1.** Positions of basis set of stations used for the surface temperature extreme index analysis (Kruger and Nxumalo, 2016).

For the precipitation indices the approach in the station selection was based on the initiative to cover the rainfall climate of South Africa as much as possible. Therefore the rainfall district areas were used to select the stations with the longest and most complete record per homogeneous rainfall area/district. Eventually it was possible to select a total of 70 stations out of a total of 94 districts which are still in operation and have near-complete data since the 1920's. Figure 2 below show the spatial distribution of the stations superimposed on the 94 homogeneous rainfall districts of South Africa. Table 2 presents the rainfall stations in alphabetical order.



**Figure 2.** Locations of rainfall stations used in the trend analysis of individual stations, with rainfall districts represented. Rainfall district borders are superimposed (Kruger and Nxumalo, 2017).

**Table 2.** Rainfall stations used in the analysis of the historical rainfall in alphabetical order.

Station Name	Latitude	Longitude
ALBERTVALE-FRM	-32.74	26.01
ALKMAAR	-25.45	30.82
BLAAUWKOP	26.5	30.27
BLOUBOSKUIL	-32.44	22.71
BOETSAP	-27.97	24.45
CALITZDORP - POL	-33.53	21.69
CAPE AGULHAS	-34.83	20.02
CARNARVON - POL	-30.97	22.13
CEDARA	-29.54	30.27
DORDRECHT CLARKS SIDING	-31.41	27.12
DWARS IN DIE WEG	-33.07	20.62
EUREKA	-29.08	24.48
EXWELL PARK	-32.21	27.1
FUNNYSTONE	-30.7	27.82
GINGINDHLOVU	-29.03	31.57
GRAHAMSTOWN - TNK	-33.32	26.49

GRAPEVALE	-31.15	25.23
HANGLIP	-23.02	29.92
HLOBANE	-27.7	30.98
HOFMEYR - MUN	-31.65	25.8
HOPETOWN	-29.62	24.08
HOPKINS	-27.71	22.7
HUGHENDEN	-30.69	26.19
IRENE	-25.87	28.22
KALKFONTEIN	-23.9	29.58
KAREEDOUW - POL	-33.95	24.29
KENDREW ESTATES	-32.52	24.48
LEKKERVLEI	-31.05	23.6
LETABA DISTRICT	-23.73	30.1
MACHADODORP	-25.67	30.25
MARYDALE - POL	-29.41	22.11
MASELSPOORT DAM	-29.03	26.41
MERWEVILLE - POL	-32.66	21.52
MOORSIDE	-28.4	29.61
MOUNT EDGECOMBE	-29.71	31.05
NIEKERKSHOOP - POL	-29.33	22.84
NIEUWOUDTVILLE SAPD	-31.37	19.12
NYLSVLEY	-24.65	28.67
OTTOSDAL - POL	-26.81	26
PIKETBERG-SAPD	-32.91	18.75
PRINCE ALBERT - TNK	-33.22	22.03
RANKINS PASS-POL	-24.53	27.91
REENEN	-32.11	19.51
RICHMOND C/K - TNK	-31.42	23.94
RIETFONTEIN SAPS	-26.74	20.03
RONDAWEL	-33.2	22.66
ROODEBLOEM	-32.18	24.57
ROOIRIVIER	-33.55	22.82
SAAIFONTEIN	-31.72	21.88
SKUKUZA	-24.99	31.59
SLANGFONTEIN	-29.72	25.55
SLURRY	-25.81	25.85
STEINKOPF	-29.27	17.74
STEYTLERVILLE - MAG	-33.33	24.34
SURPRISE STORE	-28.18	31.25
SWARTRUGGENS - POL	-25.65	26.69
TAFELKOPPIES	-26.88	30.62
THE CLIFF	-29.49	26.76
THORNLEA	-28.63	21.52
TUSCANY	-25.24	26.18
VENTERSBURG - MAG	-28.09	27.14

VILLA NORA-POL	-23.53	28.13
VREDEFORT	-27.01	27.36
VRUGBAAR	-33.63	19.04
VRYBURG PALMYRA	-26.27	24.18
VRYBURG WELGELEVEN	-26.76	24.58
WARDEN SKOOLSTRAAT	-27.85	28.96
WATERLAND	-29.22	27.22
WITBANK STREHLA	-26.21	28.91

### 3. Methodology

RClimDex is a software package developed under the auspices of the WMO ETCCDI that provides for the calculation of 27 core indices of temperature and rainfall extremes for the detection of changes in the climate (Zhang and Yang, 2004). Of these 27 core indices 10 surface temperature and 11 precipitation indices were selected which can be considered to be relevant to the South African climate. The data sets ingested into RClimDex are updated on an annual basis and then the index values recalculated. The base period, from which the percentiles for the relevant indices were calculated, was defined as 1981–2010, which can be considered to be the present general norm for similar trend studies. The statistical significance of the linear trends of the indices was evaluated by the 2-sided t-test at the 5% level, and assuming Gaussian non-correlation. The details of the temperature indices are presented in Table 2 and the rainfall indices in Table 3.

**Table 3.** List of relevant ETCCDI indices utilized in the assessment of surface temperature trends (Kruger and Nxumalo, 2016)

Index	Description	Units
TX90P	Percentage of days when TX > 90th percentile	%
TX10P	Percentage of days when TX < 10th percentile	%
TXx	Annual maximum value of TX	°C
TXn	Annual minimum value of TX	°C
WSDI	Annual number of days with at least 6 consecutive days when TX > 90th percentile	days
TNx	Annual maximum value of TN	°C
TNn	Annual minimum value of TN	°C
TN90P	Percentage of days when TN > 90th percentile	%
TN10P	Percentage of days when TN < 10th percentile	%
CSDI	Annual number of days with at least 6 consecutive days when TN < 10th percentile	days

**Table 4.** List of relevant ETCCDI indices utilized in the assessment of precipitation trends (Kruger and Nxumalo, 2017)

Index	Description	Unit
prcptot	Annual total precipitation in wet days, i.e., days with precipitation $\geq 1$ mm	mm
r95p	Annual total precipitation from daily precipitation > 95 <sup>th</sup> percentile	mm
r99p	Annual total precipitation from daily precipitation > 99 <sup>th</sup> percentile	mm
rx1day	Annual maximum 1-day precipitation	mm
r10mm	Annual count of days when precipitation $\geq 10$ mm	days
r20mm	Annual count of days when precipitation $\geq 20$ mm	days
r25mm	Annual count of days when precipitation $\geq 25$ mm	days
SDII	Simple Daily Intensity Index, annual mean of daily precipitation intensity	mm
CWD	Annual maximum length of wet spell, maximum number of consecutive days with precipitation $\geq 1$ mm	days
CDD	Annual maximum length of dry spell, maximum number of consecutive days with precipitation < 1mm	days



## 4. Results per individual weather station

### 4.1 Temperature

Tables 4 to 27 present the Start Year, End Year, Slope (Trend), p-value (statistical significance of trend – where the p-value is below 0.05 the trend is considered to be statistically significant at the 95% level of confidence) and the 2019 values for the relevant temperature indices (see Table 2) for most of the weather stations listed in Table 1 in alphabetical order.

**Table 4.** WMO ETCCDI surface temperature index trends and values for Beaufort West (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.035	0	42.3
txn	1931	2019	0.018	0.017	10.8
tnx	1931	2019	-0.005	0.597	23.1
tnn	1931	2019	0.031	0	-1.5
tx10p	1931	2019	-0.087	0	3.29
tx90p	1931	2019	0.152	0	22.19
tn10p	1931	2019	-0.22	0	3.56
tn90p	1931	2019	0.118	0	16.71
wsgi	1931	2019	0.068	0	7
csdi	1931	2019	-0.033	0.007	0

**Table 5.** WMO ETCCDI surface temperature index trends and values for Bela Bela (1937 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.007	0.221	39.4
txn	1931	2019	0.009	0.379	15.0
tnx	1931	2019	0.007	0.295	21.5
tnn	1931	2019	0.018	0.021	-1.8
tx10p	1931	2019	-0.041	0.036	6.3
tx90p	1931	2019	0.066	0.006	20.4
tn10p	1931	2019	-0.112	0	7.95
tn90p	1931	2019	0.071	0	8.26
wsgi	1931	2019	0.01	0.737	6
csdi	1931	2019	-0.105	0	0

**Table 6.** WMO ETCCDI surface temperature index trends and values for Calvinia (1941 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.025	0	41.2
txn	1931	2019	0.005	0.465	9.4
tnx	1931	2019	0.003	0.722	24.6
tnn	1931	2019	0.001	0.853	-4.3
tx10p	1931	2019	-0.019	0.16	5.75
tx90p	1931	2019	0.082	0	19.73
tn10p	1931	2019	0.015	0.351	8.49
tn90p	1931	2019	0.016	0.264	9.86
wsgi	1931	2019	0.05	0.017	22
csdi	1931	2019	-0.014	0.403	0

**Table 7.** WMO ETCCDI surface temperature index trends and values for Cape Agulhas (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.017	0.059	29.8
txn	1931	2019	0.006	0.083	13.7
tnx	1931	2019	0.014	0	21.6
tnn	1931	2019	0.022	0	8.4
tx10p	1931	2019	-0.08	0	5.76
tx90p	1931	2019	0.051	0	15.73
tn10p	1931	2019	-0.198	0	3.32
tn90p	1931	2019	0.13	0	15.08
wsgi	1931	2019	0.006	0.371	0
csdi	1931	2019	-0.073	0	0

**Table 8.** WMO ETCCDI surface temperature index trends and values for Cape Columbine (1937 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.026	0.023	35.1
txn	1931	2019	0.025	0	12.7
tnx	1931	2019	0.008	0.369	21.1
tnn	1931	2019	0.005	0.271	6.1
tx10p	1931	2019	-0.332	0	5.84
tx90p	1931	2019	0.092	0.001	9.21
tn10p	1931	2019	-0.047	0.015	9.4
tn90p	1931	2019	0.055	0.053	5.56
wsgi	1931	2019	0.081	0.092	0
csdi	1931	2019	-0.031	0.036	0

**Table 9.** WMO ETCCDI surface temperature index trends and values for Cape Point (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.042	0	34.7
txn	1931	2019	0.011	0.006	12.6
tnx	1931	2019	0.035	0	18.9
tnn	1931	2019	0.022	0	7.1
tx10p	1931	2019	-0.274	0	3.84
tx90p	1931	2019	0.076	0	12.6
tn10p	1931	2019	-0.236	0	3.84
tn90p	1931	2019	0.132	0	12.33
wsgi	1931	2019	-0.008	0.134	0
csdi	1931	2019	-0.207	0	0

**Table 10.** WMO ETCCDI surface temperature index trends and values for Cape St Blaize (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.02	0.028	37.9
txn	1931	2019	0.011	0.052	12.7
tnx	1931	2019	0.01	0.001	20.7
tnn	1931	2019	0.021	0	6.7
tx10p	1931	2019	-0.082	0	10.12
tx90p	1931	2019	0.047	0	7.95
tn10p	1931	2019	-0.098	0	3.29
tn90p	1931	2019	0.091	0	11.23
wsgi	1931	2019	-0.006	0.131	0
csdi	1931	2019	-0.042	0.004	0

**Table 11.** WMO ETCCDI surface temperature index trends and values for Cape St Francis (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.003	0.727	37.8
txn	1931	2019	0.008	0.037	14.8
tnx	1931	2019	0.021	0	22.7
tnn	1931	2019	0.023	0	5.8
tx10p	1931	2019	-0.018	0.344	2.21
tx90p	1931	2019	0.012	0.565	27.25
tn10p	1931	2019	-0.188	0	4.66
tn90p	1931	2019	0.13	0	26.14
wsgi	1931	2019	0.063	0.002	18
csdi	1931	2019	-0.057	0.002	0

**Table 12.** WMO ETCCDI surface temperature index trends and values for Cape St Lucia (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.048	0	36.4
txn	1931	2019	0.015	0.021	18.2
tnx	1931	2019	0.011	0.006	23.5
tnn	1931	2019	0.008	0.256	5.2
tx10p	1931	2019	-0.132	0	5.75
tx90p	1931	2019	0.204	0	20.09
tn10p	1931	2019	-0.132	0	6.58
tn90p	1931	2019	0.193	0	22.28
wsgi	1931	2019	0.022	0.132	0
csdi	1931	2019	-0.046	0.03	0

**Table 13.** WMO ETCCDI surface temperature index trends and values for Cape Town (1939 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.022	0.017	37.7
txn	1931	2019	0.006	0.21	14.0
tnx	1931	2019	0.033	0	19.6
tnn	1931	2019	0.036	0	1.8
tx10p	1931	2019	-0.129	0	5.16
tx90p	1931	2019	0.058	0	8.35
tn10p	1931	2019	-0.241	0	3.09
tn90p	1931	2019	0.17	0	13.25
wsgi	1931	2019	0.003	0.716	0
csdi	1931	2019	-0.024	0.01	0

**Table 14.** WMO ETCCDI surface temperature index trends and values for Cedara (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.008	0.186	39.1
txn	1931	2019	-0.002	0.722	10.8
tnx	1931	2019	0.012	0.001	18.2
tnn	1931	2019	0.029	0	-2.2
tx10p	1931	2019	-0.011	0.357	7.86
tx90p	1931	2019	0.079	0	22.82
tn10p	1931	2019	-0.165	0	4.3
tn90p	1931	2019	0.116	0	16.19
wsgi	1931	2019	0.011	0.196	0
csdi	1931	2019	-0.072	0	0

**Table 15.** WMO ETCCDI surface temperature index trends and values for East London (1941 – 2019).

P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0	0.989	34.9
txn	1931	2019	-0.007	0.297	13.8
tnx	1931	2019	-0.012	0.006	21.4
tnn	1931	2019	-0.007	0.12	4.7
tx10p	1931	2019	-0.018	0.186	6.88
tx90p	1931	2019	0.012	0.261	12.36
tn10p	1931	2019	0.067	0	6.86
tn90p	1931	2019	-0.119	0	6.88
wstdi	1931	2019	-0.004	0.285	0
csdi	1931	2019	0.002	0.67	0

**Table 16.** WMO ETCCDI surface temperature index trends and values for Emerald Dale (1931 – 2019).

P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	-0.006	0.522	37.4
txn	1931	2019	0.009	0.385	9.7
tnx	1931	2019	0.011	0.032	18.3
tnn	1931	2019	0.024	0.001	-2.9
tx10p	1931	2019	0.002	0.906	12.61
tx90p	1931	2019	-0.023	0.313	7.97
tn10p	1931	2019	-0.093	0	10.16
tn90p	1931	2019	0.057	0.001	7.14
wstdi	1931	2019	-0.005	0.657	0
csdi	1931	2019	-0.003	0.883	0

**Table 17.** WMO ETCCDI surface temperature index trends and values for Glen College (1931 – 2019).

P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.002	0.718	40.0
txn	1931	2019	0.023	0.003	13.8
tnx	1931	2019	0.003	0.639	21.4
tnn	1931	2019	0.017	0.017	-7.6
tx10p	1931	2019	-0.048	0.002	4.27
tx90p	1931	2019	0.112	0	29.42
tn10p	1931	2019	-0.078	0	6.85
tn90p	1931	2019	0.035	0.013	7.34
wstdi	1931	2019	0.124	0.003	40
csdi	1931	2019	-0.097	0	0

**Table 18.** WMO ETCCDI surface temperature index trends and values for Johannesburg (1947 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	-0.001	0.925	32.1
txn	1931	2019	-0.007	0.575	12.7
tnx	1931	2019	0.044	0	20.5
tnn	1931	2019	0.038	0	-1.3
tx10p	1931	2019	-0.003	0.864	5.63
tx90p	1931	2019	0.037	0.283	27.29
tn10p	1931	2019	-0.195	0	3.62
tn90p	1931	2019	0.278	0	28.12
wsgi	1931	2019	0.032	0.587	21
csdi	1931	2019	-0.067	0.012	0

**Table 19.** WMO ETCCDI surface temperature index trends and values for Langgewens (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.029	0	41.0
txn	1931	2019	0.018	0	12.7
tnx	1931	2019	0.019	0	22.9
tnn	1931	2019	0.019	0	3.3
tx10p	1931	2019	-0.132	0	7.19
tx90p	1931	2019	0.085	0	11.02
tn10p	1931	2019	-0.176	0	6.09
tn90p	1931	2019	0.062	0	9.08
wsgi	1931	2019	0.03	0.029	0
csdi	1931	2019	-0.088	0	0

**Table 20.** WMO ETCCDI surface temperature index trends and values for Mount Edgecombe (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.039	0	38.3
txn	1931	2019	0.013	0.018	18.1
tnx	1931	2019	0.022	0	23.9
tnn	1931	2019	0.027	0	5.2
tx10p	1931	2019	-0.161	0	6.03
tx90p	1931	2019	0.116	0	28.77
tn10p	1931	2019	-0.296	0	2.47
tn90p	1931	2019	0.204	0	36.16
wsgi	1931	2019	0.023	0.024	7
csdi	1931	2019	-0.174	0	0

**Table 21.** WMO ETCCDI surface temperature index trends and values for Musina (1934 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.007	0.239	43.1
txn	1931	2019	0	0.97	17.1
tnx	1931	2019	0.021	0.001	26.9
tnn	1931	2019	0.04	0	0.9
tx10p	1931	2019	-0.032	0.069	11.53
tx90p	1931	2019	0.043	0.011	3.85
tn10p	1931	2019	-0.196	0	8.52
tn90p	1931	2019	0.088	0	5.48
wstdi	1931	2019	0.009	0.3	0
csdi	1931	2019	-0.261	0	0

**Table 22.** WMO ETCCDI surface temperature index trends and values for Polokwane (1941 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.021	0.001	38.1
txn	1931	2019	0.016	0.073	14.7
tnx	1931	2019	0.019	0	23.8
tnn	1931	2019	0.026	0	-0.3
tx10p	1931	2019	-0.069	0	6.58
tx90p	1931	2019	0.156	0	19.45
tn10p	1931	2019	-0.171	0	2.19
tn90p	1931	2019	0.194	0	46.3
wstdi	1931	2019	0.016	0.283	0
csdi	1931	2019	-0.149	0	0

**Table 23.** WMO ETCCDI surface temperature index trends and values for Port Elizabeth (1937 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.016	0.11	36.8
txn	1931	2019	0.016	0.003	13.5
tnx	1931	2019	0.031	0	20.3
tnn	1931	2019	0.048	0	1.2
tx10p	1931	2019	-0.106	0	5.63
tx90p	1931	2019	0.051	0	12.84
tn10p	1931	2019	-0.356	0	6.59
tn90p	1931	2019	0.181	0	15.17
wstdi	1931	2019	0.006	0.096	0
csdi	1931	2019	-0.056	0	0

**Table 24.** WMO ETCCDI surface temperature index trends and values for Pretoria (1931 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.018	0.033	36.9
txn	1931	2019	0.011	0.342	15.1
tnx	1931	2019	0.047	0	20.9
tnn	1931	2019	0.049	0	0.8
tx10p	1931	2019	-0.077	0	6.37
tx90p	1931	2019	0.147	0	29.66
tn10p	1931	2019	-0.483	0	1.38
tn90p	1931	2019	0.277	0	36.02
wsgi	1931	2019	0.123	0.001	28
csdi	1931	2019	-0.748	0	0

**Table 25.** WMO ETCCDI surface temperature index trends and values for Uppington (1944 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.031	0	42.4
txn	1931	2019	0.02	0.012	14.3
tnx	1931	2019	-0.001	0.846	27.3
tnn	1931	2019	0.029	0.002	-2.0
tx10p	1931	2019	-0.105	0	2.19
tx90p	1931	2019	0.21	0	24.28
tn10p	1931	2019	-0.102	0.004	5.34
tn90p	1931	2019	0.019	0.348	10.54
wsgi	1931	2019	0.106	0	15
csdi	1931	2019	-0.095	0.03	0

**Table 26.** WMO ETCCDI surface temperature index trends and values for Vanwyksvlei (1939 – 2019). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	0.024	0	42.7
txn	1931	2019	0.008	0.168	12.1
tnx	1931	2019	0	0.96	25.5
tnn	1931	2019	0.012	0.077	-4.0
tx10p	1931	2019	-0.066	0	3.04
tx90p	1931	2019	0.133	0	25.63
tn10p	1931	2019	-0.072	0	7.15
tn90p	1931	2019	0.037	0.017	12.71
wsgi	1931	2019	0.093	0	17
csdi	1931	2019	-0.038	0.025	0



**Table 27.** WMO ETCCDI surface temperature index trends and values for Vryburg (1931 – 2017). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
txx	1931	2019	-0.003	0.639	-
txn	1931	2019	-0.006	0.466	-
tnx	1931	2019	-0.006	0.34	-
tnn	1931	2019	0.006	0.405	-
tx10p	1931	2019	0.011	0.402	-
tx90p	1931	2019	-0.019	0.489	-
tn10p	1931	2019	-0.043	0.03	-
tn90p	1931	2019	0.016	0.392	-
wsgi	1931	2019	-0.108	0.042	-
csdi	1931	2019	-0.057	0.012	-

## 4.2 Rainfall

Tables 28 to 97 present the Start Year, End Year, Slope (Trend), p-value (statistical significance of trend) and the 2018 values for the relevant rainfall indices (see Table 2) for the rainfall stations listed in Table 3 and according to rainfall district sequence.

**Table 28.** WMO ETCCDI rainfall index trends and values for STEINKOPF (District 1). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.042	0.449	3.1
rx5day	1921	2019	-0.028	0.711	4.1
sdii	1921	2019	-0.008	0.415	1.8
r10mm	1921	2019	0.006	0.529	0
r20mm	1921	2019	0.005	0.362	0
R25mm	1921	2019	-0.002	0.579	0
cdd	1921	2019	-0.234	0.192	243
cwd	1921	2019	0.003	0.406	1
r95p	1921	2019	-0.107	0.451	0
r99p	1921	2019	-0.117	0.214	0
prcptot	1921	2019	0.021	0.928	7.1

**Table 29.** WMO ETCCDI rainfall index trends and values for NIEUWOUDTVILLE SAPD (District 2). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1923	2019	0.03	0.579	-
rx5day	1923	2019	0.07	0.364	-
sdii	1923	2019	-0.027	0.002	5.6
r10mm	1923	2019	-0.012	0.412	3
r20mm	1923	2019	-0.011	0.242	1
R25mm	1923	2019	-0.004	0.645	1
cdd	1923	2019	-0.322	0.002	48
cwd	1923	2019	0.002	0.63	2
r95p	1923	2019	0.013	0.959	30.4
r99p	1923	2019	0.086	0.53	0
prcptot	1923	2019	-0.026	0.946	169.3

**Table 30.** WMO ETCCDI rainfall index trends and values for PIKETBERG-SAPD (District 3). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.024	0.602	29.0
rx5day	1921	2019	0.03	0.74	43.0
sdii	1921	2019	0.004	0.548	7.8
r10mm	1921	2019	0.008	0.639	10
r20mm	1921	2019	0.004	0.681	4
R25mm	1921	2019	-0.006	0.386	1
cdd	1921	2019	-0.023	0.786	44
cwd	1921	2019	-0.011	0.051	3
r95p	1921	2019	-0.176	0.406	29.0
r99p	1921	2019	-0.036	0.781	0
prcptot	1921	2019	-0.233	0.499	310.2

**Table 31.** WMO ETCCDI rainfall index trends and values for VRUGBAAR (District 4). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.065	0.29	36.5
rx5day	1921	2019	-0.004	0.972	53.7
sdii	1921	2019	0.011	0.04	9.5
r10mm	1921	2019	-0.01	0.649	22
r20mm	1921	2019	0.011	0.392	6
R25mm	1921	2019	0.004	0.682	2
cdd	1921	2019	0.076	0.178	23
cwd	1921	2019	0.001	0.888	4
r95p	1921	2019	0.182	0.579	36.5
r99p	1921	2019	0.098	0.562	0
prcptot	1921	2019	-0.16	0.767	572.8

**Table 32.** WMO ETCCDI rainfall index trends and values for REENEN (District 5). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.061	0.123	22.0
rx5day	1921	2019	0.077	0.163	22.0
sdii	1921	2019	-0.017	0.022	7.8
r10mm	1921	2019	0	0.972	2
r20mm	1921	2019	0.004	0.278	1
R25mm	1921	2019	0.001	0.696	0
cdd	1921	2019	-0.497	0.005	200
cwd	1921	2019	0.007	0.128	1
r95p	1921	2019	0.099	0.312	22.0
r99p	1921	2019	0.055	0.326	0
prcptot	1921	2019	0.167	0.332	46.5

**Table 33.** WMO ETCCDI rainfall index trends and values for DWARS IN DIE WEG (District 6). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.034	0.492	22.0
rx5day	1921	2019	0.054	0.352	22.0
sdii	1921	2019	0.003	0.75	8.1
r10mm	1921	2019	0.006	0.556	4
r20mm	1921	2019	0.001	0.807	1
R25mm	1921	2019	0	0.962	0
cdd	1921	2019	-0.01	0.951	81
cwd	1921	2019	0.002	0.561	2
r95p	1921	2019	0.063	0.681	0
r99p	1921	2019	0.172	0.052	0
prcptot	1921	2019	0.021	0.929	80.5

**Table 34.** WMO ETCCDI rainfall index trends and values for CAPE AGULHAS (District 7). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.026	0.795	29.0
rx5day	1921	2019	0.128	0.289	55.0
sdii	1921	2019	0.005	0.26	4.7
r10mm	1921	2019	0.007	0.672	8
r20mm	1921	2019	-0.002	0.84	1
R25mm	1921	2019	-0.002	0.723	1
cdd	1921	2019	0.04	0.207	33
cwd	1921	2019	-0.005	0.298	3
r95p	1921	2019	-0.137	0.632	29.0
r99p	1921	2019	-0.045	0.834	0
prcptot	1921	2019	-0.327	0.411	306.0

**Table 35.** WMO ETCCDI rainfall index trends and values for CALITZDORP - POL (District 8). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.165	0.009	19.5
rx5day	1921	2019	0.141	0.135	164.5
sdii	1921	2019	0.048	0	6.5
r10mm	1921	2019	0.04	0	4
r20mm	1921	2019	0.02	0.002	0
R25mm	1921	2019	0.017	0	0
cdd	1921	2019	0.014	0.863	86
cwd	1921	2019	-0.007	0.067	2
r95p	1921	2019	0.461	0.006	0
r99p	1921	2019	0.094	0.256	0
prcptot	1921	2019	0.788	0.002	104.5

**Table 36.** WMO ETCCDI rainfall index trends and values for PRINCE ALBERT - TNK (District 9). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.081	0.145	20.0
rx5day	1921	2019	0.133	0.038	20.0
sdii	1921	2019	0.042	0	4.7
r10mm	1921	2019	0.025	0.008	1
r20mm	1921	2019	0.014	0.004	1
R25mm	1921	2019	0.007	0.089	0
cdd	1921	2019	0.036	0.738	112
cwd	1921	2019	-0.003	0.302	1
r95p	1921	2019	0.244	0.07	0
r99p	1921	2019	0.056	0.506	0
prcptot	1921	2019	0.284	0.242	42.5

**Table 37.** WMO ETCCDI rainfall index trends and values for ROOIRIVIER (District 10). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1923	2019	-0.016	0.794	-
rx5day	1923	2019	0.022	0.806	-
sdii	1923	2019	0.013	0.1	-
r10mm	1923	2019	0.033	0.013	-
r20mm	1923	2019	0.007	0.223	-
R25mm	1923	2019	0.005	0.295	-
cdd	1923	2019	-0.068	0.371	-
cwd	1923	2019	0.003	0.418	-
r95p	1923	2019	0.17	0.317	-
r99p	1923	2019	0.148	0.131	-
prcptot	1923	2019	0.556	0.066	-

**Table 38.** WMO ETCCDI rainfall index trends and values for KAREEDOUW - POL (District 11). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1927	2019	0.273	0.177	-
rx5day	1927	2019	0.127	0.689	-
sdii	1927	2019	0.006	0.662	11.6
r10mm	1927	2019	-0.043	0.052	16
r20mm	1927	2019	-0.04	0.018	9
R25mm	1927	2019	-0.03	0.031	6
cdd	1927	2019	-0.005	0.953	33
cwd	1927	2019	-0.005	0.44	4
r95p	1927	2019	-0.042	0.948	146.5
r99p	1927	2019	0.301	0.444	0
prcptot	1927	2019	-1.7	0.053	594.1

**Table 39.** WMO ETCCDI rainfall index trends and values for STEYTLERVILLE - MAG (District 12). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.03	0.567	20.0
rx5day	1921	2019	0.048	0.599	31.2
sdii	1921	2019	-0.004	0.568	5.0
r10mm	1921	2019	0.022	0.056	3
r20mm	1921	2019	0.009	0.263	1
R25mm	1921	2019	0.012	0.049	0
cdd	1921	2019	0.023	0.774	103
cwd	1921	2019	0.008	0.046	3
r95p	1921	2019	0.271	0.205	0
r99p	1921	2019	0.078	0.592	0
prcptot	1921	2019	0.638	0.054	115.2

**Table 40.** WMO ETCCDI rainfall index trends and values for GRAHAMSTOWN - TNK (District 13). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.024	0.824	21.0
rx5day	1921	2019	-0.147	0.436	56.5
sdii	1921	2019	0.022	0.008	6.6
r10mm	1921	2019	0.014	0.498	15
r20mm	1921	2019	0.006	0.583	2
R25mm	1921	2019	0.006	0.562	0
cdd	1921	2019	0.181	0.001	57
cwd	1921	2019	0.003	0.562	8
r95p	1921	2019	0.099	0.834	0
r99p	1921	2019	0.109	0.739	0
prcptot	1921	2019	-0.27	0.666	376.4

**Table 41.** WMO ETCCDI rainfall index trends and values for MERWEVILLE - POL (District 16). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.122	0.087	11.5
rx5day	1921	2019	0.165	0.083	24.0
sdii	1921	2019	0.022	0.114	5.7
r10mm	1921	2019	0.002	0.859	2
r20mm	1921	2019	0.008	0.164	0
R25mm	1921	2019	0.007	0.121	0
cdd	1921	2019	-0.499	0.003	90
cwd	1921	2019	0	0.968	3
r95p	1921	2019	0.305	0.056	0
r99p	1921	2019	0.079	0.371	0
prcptot	1921	2019	0.177	0.508	56.5

**Table 42.** WMO ETCCDI rainfall index trends and values for RONDAWEL (District 17). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.058	0.166	15.0
rx5day	1921	2019	0.097	0.061	15.0
sdii	1921	2019	-0.003	0.756	5.8
r10mm	1921	2019	0.04	0	2
r20mm	1921	2019	0.012	0.036	0
R25mm	1921	2019	0.007	0.054	0
cdd	1921	2019	-0.767	0	67
cwd	1921	2019	0.002	0.474	1
r95p	1921	2019	0.245	0.061	0
r99p	1921	2019	0.081	0.343	0
prcptot	1921	2019	0.964	0	69.5

**Table 43.** WMO ETCCDI rainfall index trends and values for SAAIFONTEIN (District 19). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.062	0.34	23.5
rx5day	1921	2019	0.047	0.609	23.5
sdii	1921	2019	-0.005	0.724	9.7
r10mm	1921	2019	0.038	0.005	3
r20mm	1921	2019	0.013	0.122	1
R25mm	1921	2019	0.009	0.143	0
cdd	1921	2019	-0.305	0.103	148
cwd	1921	2019	0.002	0.526	2
r95p	1921	2019	0.423	0.028	0
r99p	1921	2019	0.102	0.444	0
prcptot	1921	2019	1.077	0.004	77.5

**Table 44.** WMO ETCCDI rainfall index trends and values for BLOUBOSKUIL (District 20). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.057	0.321	60.0
rx5day	1921	2019	0.047	0.625	73.0
sdii	1921	2019	0.004	0.671	14.0
r10mm	1921	2019	0.04	0.001	4
r20mm	1921	2019	0.007	0.264	1
R25mm	1921	2019	0	0.926	1
cdd	1921	2019	-0.233	0.034	124
cwd	1921	2019	0.006	0.096	3
r95p	1921	2019	0.01	0.955	60.0
r99p	1921	2019	0.065	0.518	60.0
prcptot	1921	2019	0.797	0.009	125.6

**Table 45.** WMO ETCCDI rainfall index trends and values for KENDREW ESTATES (District 21). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0	0.995	22.0
rx5day	1921	2019	0.006	0.952	35.6
sdii	1921	2019	0.002	0.836	8.1
r10mm	1921	2019	0.02	0.181	4
r20mm	1921	2019	0.013	0.098	2
R25mm	1921	2019	0.01	0.155	0
cdd	1921	2019	0.016	0.874	124
cwd	1921	2019	0.011	0.02	2
r95p	1921	2019	0.257	0.293	0
r99p	1921	2019	-0.024	0.882	0
prcptot	1921	2019	0.453	0.251	128.8

**Table 46.** WMO ETCCDI rainfall index trends and values for ALBERTVALE-FRM (District 22). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2018 value
rx1day	1921	2019	-0.03	0.724	37.0
rx5day	1921	2019	-0.058	0.685	51.0
sdii	1921	2019	0.018	0.003	9.9
r10mm	1921	2019	0.053	0.002	11
r20mm	1921	2019	0.025	0.014	2
R25mm	1921	2019	0.022	0.005	1
cdd	1921	2019	0.024	0.7	95
cwd	1921	2019	-0.003	0.56	3
r95p	1921	2019	0.513	0.114	37.0
r99p	1921	2019	-0.047	0.828	0
prcptot	1921	2019	1.014	0.036	247.0

**Table 47.** WMO ETCCDI rainfall index trends and values for MOUNT EDGECOMBE (District 25). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1927	2019	0.088	0.682	161.8
rx5day	1927	2019	0.048	0.888	183.2
sdii	1927	2019	0.002	0.881	12.6
r10mm	1927	2019	-0.044	0.106	24
r20mm	1927	2019	-0.017	0.378	14
R25mm	1927	2019	-0.013	0.465	13
cdd	1927	2019	0.128	0.04	46
cwd	1927	2019	-0.01	0.116	7
r95p	1927	2019	-0.008	0.993	536.4
r99p	1927	2019	0.368	0.518	161.8
prcptot	1927	2019	-0.809	0.508	1148.0

**Table 48.** WMO ETCCDI rainfall index trends and values for GINGINDHLOVU (District 26). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2018 value
rx1day	1921	2019	0.373	0.107	47.0
rx5day	1921	2019	0.627	0.072	69.0
sdii	1921	2019	0.015	0.11	9.2
r10mm	1921	2019	0.038	0.241	35
r20mm	1921	2019	0.014	0.477	10
R25mm	1921	2019	0.021	0.186	5
cdd	1921	2019	-0.005	0.893	34
cwd	1921	2019	0.009	0.102	6
r95p	1921	2019	0.763	0.327	89.0
r99p	1921	2019	0.922	0.049	0
prcptot	1921	2019	1.026	0.336	767.2

**Table 49.** WMO ETCCDI rainfall index trends and values for EXWELL PARK (District 27). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.025	0.66	30.1
rx5day	1921	2019	0.017	0.858	68.5
sdii	1921	2019	0.003	0.628	10.2
r10mm	1921	2019	-0.006	0.723	11
r20mm	1921	2019	0.005	0.643	3
R25mm	1921	2019	0.012	0.139	3
cdd	1921	2019	-0.204	0.105	67
cwd	1921	2019	-0.008	0.136	6
r95p	1921	2019	0.019	0.934	0
r99p	1921	2019	0.114	0.438	0
prcptot	1921	2019	-0.142	0.736	285.1



**Table 50.** WMO ETCCDI rainfall index trends and values for CEDARA (District 30). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.079	0.574	29.6
rx5day	1921	2019	0.058	0.782	71.4
sdii	1921	2019	-0.002	0.724	5.6
r10mm	1921	2019	-0.049	0.025	15
r20mm	1921	2019	-0.022	0.072	5
R25mm	1921	2019	-0.019	0.078	2
cdd	1921	2019	0	0.994	75
cwd	1921	2019	-0.006	0.321	7
r95p	1921	2019	-0.297	0.524	29.6
r99p	1921	2019	-0.128	0.714	0
prcptot	1921	2019	-1.237	0.051	507

**Table 51.** WMO ETCCDI rainfall index trends and values for SURPRISE STORE (District 31). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1933	2019	0.066	0.768	55.5
rx5day	1933	2019	0.217	0.57	81.1
sdii	1933	2019	-0.038	0.022	6.9
r10mm	1933	2019	-0.085	0.009	14
r20mm	1933	2019	-0.054	0.013	7
R25mm	1933	2019	-0.029	0.096	3
cdd	1933	2019	-0.09	0.539	58
cwd	1933	2019	-0.001	0.879	7
r95p	1933	2019	0.109	0.884	55.5
r99p	1933	2019	0.32	0.517	0
prcptot	1933	2019	-1.503	0.157	444.2

**Table 52.** WMO ETCCDI rainfall index trends and values for SKUKUZA (District 33). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.249	0.075	64.2
rx5day	1921	2019	-0.114	0.641	99.6
sdii	1921	2019	-0.045	0.002	11.5
r10mm	1921	2019	-0.014	0.499	16
r20mm	1921	2019	0.001	0.96	7
R25mm	1921	2019	0.006	0.638	3
cdd	1921	2019	-0.184	0.178	133
cwd	1921	2019	-0.011	0.081	5
r95p	1921	2019	-0.484	0.32	64.2
r99p	1921	2019	-0.243	0.477	0
prcptot	1921	2019	-0.122	0.866	438.6

**Table 53.** WMO ETCCDI rainfall index trends and values for CARNARVON - POL (District 38). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.005	0.95	15.0
rx5day	1921	2019	0.119	0.311	15.0
sdii	1921	2019	0.014	0.427	5.4
r10mm	1921	2019	0.004	0.744	1
r20mm	1921	2019	0.01	0.21	0
R25mm	1921	2019	0.009	0.154	0
cdd	1921	2019	0.05	0.744	215
cwd	1921	2019	0.002	0.561	1
r95p	1921	2019	0.089	0.665	0
r99p	1921	2019	0.01	0.939	0
prcptot	1921	2019	-0.02	0.957	37.5

**Table 54.** WMO ETCCDI rainfall index trends and values for RICHMOND C/K - TNK (District 39). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.025	0.624	16.0
rx5day	1921	2019	0.027	0.751	27.0
sdii	1921	2019	0.002	0.772	7.2
r10mm	1921	2019	0.007	0.638	3
r20mm	1921	2019	0	0.993	0
R25mm	1921	2019	0.003	0.635	0
cdd	1921	2019	-0.014	0.887	106
cwd	1921	2019	0.002	0.593	3
r95p	1921	2019	0.015	0.948	0
r99p	1921	2019	-0.001	0.996	0
prcptot	1921	2019	0.263	0.531	114.9

**Table 55.** WMO ETCCDI rainfall index trends and values for ROODEBLOEM (District 40). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.11	0.058	43.0
rx5day	1921	2019	0.08	0.326	44.0
sdii	1921	2019	0.001	0.784	9.1
r10mm	1921	2019	0.037	0.002	9
r20mm	1921	2019	0.016	0.029	2
R25mm	1921	2019	0.007	0.167	1
cdd	1921	2019	-0.085	0.224	124
cwd	1921	2019	0.01	0.007	3
r95p	1921	2019	0.292	0.122	43.0
r99p	1921	2019	0.163	0.159	0
prcptot	1921	2019	1.106	0.001	209.5

**Table 56.** WMO ETCCDI rainfall index trends and values for HOFMEYR - MUN (District 41). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.17	0.033	35.0
rx5day	1921	2019	0.211	0.052	60.0
sdii	1921	2019	0.025	0.031	8.2
r10mm	1921	2019	0.057	0.014	8
r20mm	1921	2019	0.021	0.08	4
R25mm	1921	2019	0.015	0.09	9
cdd	1921	2019	0.205	0.123	124
cwd	1921	2019	-0.003	0.518	4
r95p	1921	2019	0.167	0.589	35.0
r99p	1921	2019	0.189	0.284	0
prcptot	1921	2019	0.928	0.093	262.0

**Table 57.** WMO ETCCDI rainfall index trends and values for DORDRECHT CLARKS SIDING (District 42). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2018 value
rx1day	1921	2019	-0.086	0.253	29.7
rx5day	1921	2019	-0.167	0.225	65.5
sdii	1921	2019	-0.034	0	8.5
r10mm	1921	2019	0.015	0.545	22
r20mm	1921	2019	-0.002	0.893	7
R25mm	1921	2019	-0.002	0.859	1
cdd	1921	2019	-0.199	0.016	124
cwd	1921	2019	0.014	0.018	6
r95p	1921	2019	-0.297	0.462	0
r99p	1921	2019	-0.374	0.13	0
prcptot	1921	2019	0.523	0.423	542.6

**Table 58.** WMO ETCCDI rainfall index trends and values for MOORSIDE (District 44). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2018 value
rx1day	1921	2019	-0.084	0.407	62.5
rx5day	1921	2019	-0.035	0.813	109.7
sdii	1921	2019	-0.017	0.074	15.3
r10mm	1921	2019	-0.049	0.037	25
r20mm	1921	2019	-0.018	0.265	15
R25mm	1921	2019	-0.008	0.565	11
cdd	1921	2019	-0.038	0.767	160
cwd	1921	2019	-0.002	0.716	6
r95p	1921	2019	0.326	0.478	272.0
r99p	1921	2019	0.1	0.677	0
prcptot	1921	2019	-0.697	0.315	813.4

**Table 59.** WMO ETCCDI rainfall index trends and values for HLOBANE (District 45). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.528	0	106.5
rx5day	1921	2019	0.596	0	112.0
sdii	1921	2019	0.068	0	23.4
r10mm	1921	2019	0.063	0.008	24
r20mm	1921	2019	0.058	0	16
R25mm	1921	2019	0.058	0	14
cdd	1921	2019	0.072	0.516	163
cwd	1921	2019	-0.012	0.024	5
r95p	1921	2019	2.301	0	328.5
r99p	1921	2019	0.951	0	106.5
prcptot	1921	2019	2.264	0.001	818.6

**Table 60.** WMO ETCCDI rainfall index trends and values for TAFELKOPPIES (District 46). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.12	0.465	80.0
rx5day	1921	2019	0.324	0.102	130.0
sdii	1921	2019	-0.026	0.009	14.2
r10mm	1921	2019	-0.008	0.739	25
r20mm	1921	2019	0.01	0.503	16
R25mm	1921	2019	0.008	0.513	11
cdd	1921	2019	-0.144	0.179	135
cwd	1921	2019	0.003	0.659	6
r95p	1921	2019	0.873	0.074	273.0
r99p	1921	2019	0.453	0.131	80.0
prcptot	1921	2019	0.896	0.199	835.9

**Table 61.** WMO ETCCDI rainfall index trends and values for ALKMAAR (District 47). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2018 value
rx1day	1921	2019	0.197	0.162	58.0
rx5day	1921	2019	0.247	0.24	86.0
sdii	1921	2019	-0.03	0.002	10.4
r10mm	1921	2019	0.003	0.9	24
r20mm	1921	2019	0.005	0.77	10
R25mm	1921	2019	0	0.986	7
cdd	1921	2019	-0.414	0	63
cwd	1921	2019	-0.002	0.855	6
r95p	1921	2019	0.562	0.322	58.0
r99p	1921	2019	0.47	0.179	0
prcptot	1921	2019	0.796	0.347	611.9

**Table 62.** WMO ETCCDI rainfall index trends and values for LETABA DISTRICT (District 49). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.427	0.126	72.0
rx5day	1921	2019	-0.533	0.209	98.5
sdii	1921	2019	-0.011	0.588	11.0
r10mm	1921	2019	-0.113	0	22
r20mm	1921	2019	-0.059	0.013	13
R25mm	1921	2019	-0.061	0.005	8
cdd	1921	2019	-0.238	0.005	45
cwd	1921	2019	-0.055	0	5
r95p	1921	2019	-0.429	0.644	135.0
r99p	1921	2019	0.886	0.164	0
prcptot	1921	2019	-3.333	0.02	815.3

**Table 63.** WMO ETCCDI rainfall index trends and values for HANGLIP (District 50). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.038	0.736	90.0
rx5day	1921	2019	-0.141	0.556	186.0
sdii	1921	2019	0.01	0.394	19.0
r10mm	1921	2019	-0.081	0.004	24
r20mm	1921	2019	-0.017	0.363	15
R25mm	1921	2019	-0.017	0.225	11
cdd	1921	2019	0.287	0.006	147
cwd	1921	2019	-0.04	0	4
r95p	1921	2019	-0.305	0.625	357.0
r99p	1921	2019	-0.048	0.904	90.0
prcptot	1921	2019	-2.099	0.029	816.0

**Table 64.** WMO ETCCDI rainfall index trends and values for THORNLEA (District 52). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.035	0.556	30.0
rx5day	1921	2019	0.093	0.265	30.0
sdii	1921	2019	0.041	0.005	11.2
r10mm	1921	2019	0.003	0.808	1
r20mm	1921	2019	0.011	0.115	1
R25mm	1921	2019	0.009	0.089	1
cdd	1921	2019	0.19	0.263	254
cwd	1921	2019	-0.005	0.154	1
r95p	1921	2019	0.137	0.489	0
r99p	1921	2019	0.002	0.99	0
prcptot	1921	2019	-0.112	0.743	45.0

**Table 65.** WMO ETCCDI rainfall index trends and values for MARYDALE - POL (District 53). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.005	0.954	2.0
rx5day	1921	2019	-0.002	0.989	2.0
sdii	1921	2019	-0.007	0.624	2.0
r10mm	1921	2019	0.019	0.137	0
r20mm	1921	2019	0.008	0.292	0
R25mm	1921	2019	0.001	0.846	0
cdd	1921	2019	-0.061	0.715	304
cwd	1921	2019	0.005	0.162	1
r95p	1921	2019	0.073	0.771	0
r99p	1921	2019	-0.11	0.61	0
prcptot	1921	2019	0.281	0.467	2.0

**Table 66.** WMO ETCCDI rainfall index trends and values for LEKKERVLEI (District 54). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.105	0.046	33.0
rx5day	1921	2019	0.199	0.032	60.0
sdii	1921	2019	0.007	0.306	9.8
r10mm	1921	2019	0.022	0.092	5
r20mm	1921	2019	0.019	0.017	2
R25mm	1921	2019	0.012	0.052	2
cdd	1921	2019	-0.271	0.073	110
cwd	1921	2019	0.002	0.698	2
r95p	1921	2019	0.302	0.15	33.0
r99p	1921	2019	0.149	0.196	0
prcptot	1921	2019	0.696	0.071	156.0

**Table 67.** WMO ETCCDI rainfall index trends and values for GRAPEVALE (District 55). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.094	0.075	33.0
rx5day	1921	2019	0.086	0.405	69.5
sdii	1921	2019	0.019	0.01	11.1
r10mm	1921	2019	0.059	0.003	11
r20mm	1921	2019	0.024	0.036	4
R25mm	1921	2019	0.018	0.03	3
cdd	1921	2019	-0.05	0.632	193
cwd	1921	2019	0	0.959	3
r95p	1921	2019	0.335	0.168	33.0
r99p	1921	2019	0.238	0.04	0
prcptot	1921	2019	1.064	0.034	277.5

**Table 68.** WMO ETCCDI rainfall index trends and values for HUGHENDEN (District 56). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.129	0.038	39.5
rx5day	1921	2019	0.224	0.036	91.5
sdii	1921	2019	0.012	0.162	10.8
r10mm	1921	2019	0.025	0.244	13
r20mm	1921	2019	0.021	0.114	10
R25mm	1921	2019	0.01	0.288	5
cdd	1921	2019	0.308	0.013	207
cwd	1921	2019	0.003	0.605	6
r95p	1921	2019	0.567	0.05	39.5
r99p	1921	2019	0.365	0.052	0
prcptot	1921	2019	0.779	0.19	432.6

**Table 69.** WMO ETCCDI rainfall index trends and values for FUNNYSTONE (District 57). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1927	2019	0.067	0.313	46.0
rx5day	1927	2019	0.082	0.361	91.7
sdii	1927	2019	0.004	0.502	12.1
r10mm	1927	2019	0.043	0.125	29
r20mm	1927	2019	0.027	0.083	11
R25mm	1927	2019	0.01	0.357	9
cdd	1927	2019	-0.018	0.764	89
cwd	1927	2019	0.006	0.379	6
r95p	1927	2019	0.207	0.568	189.5
r99p	1927	2019	0.301	0.241	0
prcptot	1927	2019	1.029	0.126	760.8

**Table 70.** WMO ETCCDI rainfall index trends and values for WARDEN SKOOLSTRAAT (District 60). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.107	0.295	62.0
rx5day	1921	2019	0.193	0.134	105.5
sdii	1921	2019	0.045	0	17.4
r10mm	1921	2019	-0.022	0.405	18
r20mm	1921	2019	-0.007	0.655	10
R25mm	1921	2019	0.005	0.723	8
cdd	1921	2019	0.254	0.092	195
cwd	1921	2019	-0.007	0.134	3
r95p	1921	2019	0.684	0.089	167.5
r99p	1921	2019	0.298	0.162	0
prcptot	1921	2019	-0.553	0.451	538.8

**Table 71.** WMO ETCCDI rainfall index trends and values for VERKYKERSKOP- POL (District 61). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.136	0.03	-
rx5day	1921	2019	-0.165	0.089	-
sdii	1921	2019	-0.007	0.469	12.1
r10mm	1921	2019	-0.081	0	23
r20mm	1921	2019	-0.037	0.008	11
R25mm	1921	2019	-0.037	0	5
cdd	1921	2019	0.016	0.906	191
cwd	1921	2019	-0.015	0.006	3
r95p	1921	2019	-1.029	0.002	69.5
r99p	1921	2019	-0.323	0.094	0
prcptot	1921	2019	-2.835	0	510.0

**Table 72.** WMO ETCCDI rainfall index trends and values for BLAAUWKOP (District 62). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1928	2019	-0.043	0.632	84.0
rx5day	1928	2019	0.014	0.911	145.0
sdii	1928	2019	0.02	0.004	14.7
r10mm	1928	2019	0.022	0.32	24
r20mm	1928	2019	0	0.986	14
R25mm	1928	2019	-0.004	0.727	9
cdd	1928	2019	0.336	0.011	137
cwd	1928	2019	-0.006	0.266	4
r95p	1928	2019	-0.046	0.907	269.0
r99p	1928	2019	-0.195	0.424	84.0
prcptot	1928	2019	-0.622	0.312	778.0

**Table 73.** WMO ETCCDI rainfall index trends and values for MACHADODORP (District 63). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.03	0.665	52.5
rx5day	1921	2019	0.057	0.566	115.5
sdii	1921	2019	0.053	0	13.7
r10mm	1921	2019	0.031	0.2	27
r20mm	1921	2019	0.026	0.055	14
R25mm	1921	2019	0.024	0.026	11
cdd	1921	2019	0.206	0.058	72
cwd	1921	2019	-0.041	0	5
r95p	1921	2019	0.386	0.214	92.5
r99p	1921	2019	0.067	0.707	0
prcptot	1921	2019	-0.139	0.806	712.9



**Table 74.** WMO ETCCDI rainfall index trends and values for KALKFONTEIN (District 64). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.012	0.858	85.0
rx5day	1921	2019	0.112	0.332	85.0
sdii	1921	2019	0.026	0.051	31.2
r10mm	1921	2019	0.011	0.526	12
r20mm	1921	2019	0.019	0.107	10
R25mm	1921	2019	-0.002	0.821	5
cdd	1921	2019	0.422	0.005	236
cwd	1921	2019	0.003	0.568	2
r95p	1921	2019	0.274	0.414	264.0
r99p	1921	2019	0.083	0.616	170.0
prcptot	1921	2019	0.071	0.895	436.5

**Table 75.** WMO ETCCDI rainfall index trends and values for NIEKERKSHOOP - POL (District 68). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.034	0.629	11.5
rx5day	1921	2019	0.078	0.457	11.5
sdii	1921	2019	0.019	0.098	4.3
r10mm	1921	2019	0.026	0.112	2
r20mm	1921	2019	0.012	0.181	0
R25mm	1921	2019	0.008	0.189	0
cdd	1921	2019	0.016	0.905	150
cwd	1921	2019	0.004	0.39	3
r95p	1921	2019	0.391	0.052	0
r99p	1921	2019	0.117	0.435	0
prcptot	1921	2019	0.451	0.295	47.7

**Table 76.** WMO ETCCDI rainfall index trends and values for HOPETOWN (District 69). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.055	0.334	17.0
rx5day	1921	2019	0.191	0.078	43.8
sdii	1921	2019	0.017	0.112	6.9
r10mm	1921	2019	0.022	0.176	5
r20mm	1921	2019	0.008	0.38	0
R25mm	1921	2019	0.009	0.228	0
cdd	1921	2019	-0.099	0.484	131
cwd	1921	2019	0.007	0.134	5
r95p	1921	2019	0.287	0.188	0
r99p	1921	2019	0.18	0.146	0
prcptot	1921	2019	0.457	0.312	138.4

**Table 77.** WMO ETCCDI rainfall index trends and values for SLANGFONTEIN (District 70). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1923	2019	-0.014	0.805	51.1
rx5day	1923	2019	0.188	0.148	114.1
sdii	1923	2019	-0.032	0.007	11.8
r10mm	1923	2019	0.034	0.13	17
r20mm	1923	2019	0.02	0.111	8
R25mm	1923	2019	0.009	0.398	4
cdd	1923	2019	-0.245	0.068	150
cwd	1923	2019	0.012	0.001	5
r95p	1923	2019	0.237	0.521	147.6
r99p	1923	2019	-0.005	0.978	0
prcptot	1923	2019	1.176	0.05	518.7

**Table 78.** WMO ETCCDI rainfall index trends and values for THE CLIFF (District 71). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.087	0.292	39.0
rx5day	1921	2019	0.039	0.738	65.5
sdii	1921	2019	0.055	0	12.1
r10mm	1921	2019	0.033	0.105	22
r20mm	1921	2019	0.034	0.007	8
R25mm	1921	2019	0.026	0.005	4
cdd	1921	2019	0.349	0.006	186
cwd	1921	2019	-0.008	0.078	4
r95p	1921	2019	0.511	0.097	0
r99p	1921	2019	0.223	0.207	0
prcptot	1921	2019	0.462	0.392	509.5

**Table 79.** WMO ETCCDI rainfall index trends and values for WATERLAND (District 72). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.006	0.932	55.0
rx5day	1921	2019	0.01	0.919	81.4
sdii	1921	2019	0.027	0	12.7
r10mm	1921	2019	0.01	0.656	24
r20mm	1921	2019	0.012	0.341	7
R25mm	1921	2019	0.014	0.14	5
cdd	1921	2019	0.182	0.099	180
cwd	1921	2019	-0.001	0.866	4
r95p	1921	2019	0.584	0.038	135.0
r99p	1921	2019	-0.012	0.945	55.0
prcptot	1921	2019	-0.062	0.906	582.8

**Table 80.** WMO ETCCDI rainfall index trends and values for VREDEFORT (District 73). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.049	0.493	43.0
rx5day	1921	2019	-0.189	0.117	74.5
sdii	1921	2019	-0.002	0.895	15.8
r10mm	1921	2019	-0.062	0.018	22
r20mm	1921	2019	-0.037	0.009	14
R25mm	1921	2019	-0.015	0.217	11
cdd	1921	2019	0.123	0.42	118
cwd	1921	2019	0.002	0.777	5
r95p	1921	2019	-0.358	0.357	161.5
r99p	1921	2019	-0.454	0.125	0
prcptot	1921	2019	-1.807	0.011	630.5

**Table 81.** WMO ETCCDI rainfall index trends and values for IRENE (District 74). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.093	0.247	115.0
rx5day	1921	2019	0.341	0.013	201.0
sdii	1921	2019	0.014	0.024	18.0
r10mm	1921	2019	0.025	0.2	30
r20mm	1921	2019	0.015	0.188	14
R25mm	1921	2019	0.019	0.047	12
cdd	1921	2019	-0.042	0.714	174
cwd	1921	2019	0.003	0.627	8
r95p	1921	2019	0.716	0.047	379.5
r99p	1921	2019	0.108	0.614	180.5
prcptot	1921	2019	0.895	0.08	934.8

**Table 82.** WMO ETCCDI rainfall index trends and values for WITBANK STREHLA (District 75). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.045	0.53	56.0
rx5day	1921	2019	0.22	0.066	91.0
sdii	1921	2019	0.031	0	13.4
r10mm	1921	2019	0.042	0.075	27
r20mm	1921	2019	0.026	0.072	11
R25mm	1921	2019	0.019	0.083	7
cdd	1921	2019	0.233	0.06	133
cwd	1921	2019	0.005	0.296	8
r95p	1921	2019	0.617	0.083	146.0
r99p	1921	2019	0.204	0.361	0
prcptot	1921	2019	0.576	0.357	710.0

**Table 83.** WMO ETCCDI rainfall index trends and values for NYLSVLEY (District 76). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.155	0.075	40.0
rx5day	1921	2019	0.17	0.172	103.0
sdii	1921	2019	0.033	0.002	8.9
r10mm	1921	2019	0.007	0.713	16
r20mm	1921	2019	0.018	0.125	6
R25mm	1921	2019	0.014	0.18	2
cdd	1921	2019	0.361	0.006	186
cwd	1921	2019	-0.014	0.03	8
r95p	1921	2019	0.768	0.038	0
r99p	1921	2019	0.536	0.025	0
prcptot	1921	2019	0.245	0.649	410.1

**Table 84.** WMO ETCCDI rainfall index trends and values for VILLA NORA-POL (District 77). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.123	0.318	36.0
rx5day	1921	2019	-0.224	0.183	51.0
sdii	1921	2019	-0.043	0.021	13.7
r10mm	1921	2019	-0.04	0.01	9
r20mm	1921	2019	-0.021	0.034	4
R25mm	1921	2019	-0.024	0.004	2
cdd	1921	2019	0.08	0.619	221
cwd	1921	2019	-0.011	0.027	2
r95p	1921	2019	-0.746	0.03	0
r99p	1921	2019	-0.048	0.817	0
prcptot	1921	2019	-1.608	0.001	207.5

**Table 85.** WMO ETCCDI rainfall index trends and values for HOPKINS (District 79). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.036	0.574	13.0
rx5day	1921	2019	-0.076	0.535	36.0
sdii	1921	2019	0.035	0.001	7.0
r10mm	1921	2019	0	0.984	4
r20mm	1921	2019	0.008	0.468	0
R25mm	1921	2019	0.008	0.412	0
cdd	1921	2019	0.321	0.072	223
cwd	1921	2019	-0.018	0.003	5
r95p	1921	2019	0.217	0.479	0
r99p	1921	2019	0.124	0.46	0
prcptot	1921	2019	-0.113	0.844	91.5

**Table 86.** WMO ETCCDI rainfall index trends and values for BOETSAP (District 80). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.035	0.617	46.0
rx5day	1921	2019	0.081	0.498	46.0
sdii	1921	2019	0.015	0.226	10.2
r10mm	1921	2019	0.001	0.959	12
r20mm	1921	2019	0.004	0.765	3
R25mm	1921	2019	0.007	0.451	2
cdd	1921	2019	0.252	0.085	180
cwd	1921	2019	-0.002	0.755	5
r95p	1921	2019	0.057	0.87	80.0
r99p	1921	2019	0.066	0.742	0
prcptot	1921	2019	-0.498	0.404	326.4

**Table 87.** WMO ETCCDI rainfall index trends and values for EUREKA (District 81). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.049	0.5	33.0
rx5day	1921	2019	0.092	0.529	61.0
sdii	1921	2019	0.007	0.415	8.2
r10mm	1921	2019	0.023	0.207	11
r20mm	1921	2019	0.009	0.356	4
R25mm	1921	2019	0.01	0.176	3
cdd	1921	2019	0.017	0.892	158
cwd	1921	2019	0.001	0.75	5
r95p	1921	2019	0.187	0.506	33.0
r99p	1921	2019	0.065	0.663	0
prcptot	1921	2019	0.507	0.317	328.5

**Table 88.** WMO ETCCDI rainfall index trends and values for MASELSPOORT DAM (District 82). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.085	0.314	35.0
rx5day	1921	2019	0.147	0.256	67.5
sdii	1921	2019	0.041	0.002	9.7
r10mm	1921	2019	0.023	0.309	15
r20mm	1921	2019	0.034	0.013	6
R25mm	1921	2019	0.025	0.047	5
cdd	1921	2019	0.248	0.051	181
cwd	1921	2019	-0.004	0.472	5
r95p	1921	2019	1.086	0.039	0
r99p	1921	2019	0.461	0.198	0
prcptot	1921	2019	0.692	0.352	415.0

**Table 89.** WMO ETCCDI rainfall index trends and values for VENTERSBURG-MAG (District 83). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.065	0.327	36.0
rx5day	1921	2019	0.066	0.481	73.5
sdii	1921	2019	0.022	0.027	12.6
r10mm	1921	2019	-0.026	0.225	20
r20mm	1921	2019	-0.016	0.208	7
R25mm	1921	2019	-0.005	0.62	2
cdd	1921	2019	0.293	0.061	182
cwd	1921	2019	-0.009	0.041	4
r95p	1921	2019	0.346	0.225	0
r99p	1921	2019	0.236	0.127	0
prcptot	1921	2019	-0.817	0.153	427.8

**Table 90.** WMO ETCCDI rainfall index trends and values for OTTOSDAL - POL (District 84). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.142	0.038	73.0
rx5day	1921	2019	0.214	0.083	99.5
sdii	1921	2019	0.015	0.179	20.4
r10mm	1921	2019	-0.009	0.685	21
r20mm	1921	2019	0.028	0.071	18
R25mm	1921	2019	0.021	0.058	10
cdd	1921	2019	0.012	0.935	168
cwd	1921	2019	-0.006	0.205	3
r95p	1921	2019	0.358	0.258	208
r99p	1921	2019	0.412	0.035	73
prcptot	1921	2019	0.204	0.734	674.2

**Table 91.** WMO ETCCDI rainfall index trends and values for SWARTRUGGENS - POL (District 85). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.239	0.015	115.0
rx5day	1921	2019	0.24	0.128	124.0
sdii	1921	2019	0.047	0	21.0
r10mm	1921	2019	-0.02	0.36	19
r20mm	1921	2019	0.014	0.334	10
R25mm	1921	2019	0.01	0.377	9
cdd	1921	2019	0.338	0.049	190
cwd	1921	2019	-0.019	0.003	4
r95p	1921	2019	0.652	0.04	225.5
r99p	1921	2019	0.371	0.025	115.0
prcptot	1921	2019	-0.246	0.7	651.0

**Table 92.** WMO ETCCDI rainfall index trends and values for RANKINS PASS-POL (District 86). P-values below 0.05 indicate the trend to be significant at the 5% level

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.111	0.156	-
rx5day	1921	2019	0.149	0.252	-
sdii	1921	2019	0.059	0	-
r10mm	1921	2019	-0.04	0.054	-
r20mm	1921	2019	0.001	0.955	-
R25mm	1921	2019	0.009	0.415	-
cdd	1921	2019	0.503	0	-
cwd	1921	2019	-0.023	0	-
r95p	1921	2019	0.284	0.396	-
r99p	1921	2019	0.335	0.081	-
prcptot	1921	2019	-1.174	0.06	-

**Table 93.** WMO ETCCDI rainfall index trends and values for VRYBURG PALMYRA (District 89). P-values below 0.05 indicate the trend to be significant at the 5% level

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.099	0.221	55.0
rx5day	1921	2019	0.314	0.028	73.5
sdii	1921	2019	0.059	0	12.6
r10mm	1921	2019	0.062	0.005	12
r20mm	1921	2019	0.035	0.018	6
R25mm	1921	2019	0.024	0.019	6
cdd	1921	2019	0.176	0.226	177
cwd	1921	2019	0.001	0.927	3
r95p	1921	2019	0.485	0.072	105.5
r99p	1921	2019	0.194	0.166	0
prcptot	1921	2019	0.916	0.119	389.5

**Table 94.** WMO ETCCDI rainfall index trends and values for VRYBURG WELGELEVEN (District 90). P-values below 0.05 indicate the trend to be significant at the 5% level

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	-0.047	0.596	55.0
rx5day	1921	2019	0.092	0.545	107.0
sdii	1921	2019	-0.018	0.215	18.2
r10mm	1921	2019	-0.004	0.841	21
r20mm	1921	2019	0	0.998	9
R25mm	1921	2019	0.002	0.872	7
cdd	1921	2019	0.148	0.363	209
cwd	1921	2019	0.004	0.334	4
r95p	1921	2019	0.092	0.804	229.0
r99p	1921	2019	0.032	0.89	0
prcptot	1921	2019	-0.174	0.774	546.0

**Table 95.** WMO ETCCDI rainfall index trends and values for SLURRY (District 92). P-values below 0.05 indicate the trend to be significant at the 5% level

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.032	0.675	40.5
rx5day	1921	2019	0.059	0.608	69.8
sdii	1921	2019	0.039	0	11.0
r10mm	1921	2019	-0.014	0.485	15
r20mm	1921	2019	0.011	0.306	6
R25mm	1921	2019	0.01	0.298	6
cdd	1921	2019	0.401	0.005	173
cwd	1921	2019	-0.011	0.04	5
r95p	1921	2019	0.119	0.662	79.0
r99p	1921	2019	-0.028	0.867	0
prcptot	1921	2019	-0.719	0.154	427.9

**Table 96.** WMO ETCCDI rainfall index trends and values for TUSCANY (District 93). P-values below 0.05 indicate the trend to be significant at the 5% level.

Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.057	0.663	64.0
rx5day	1921	2019	0.177	0.35	164.5
sdii	1921	2019	-0.024	0.11	20.9
r10mm	1921	2019	0.004	0.852	23
r20mm	1921	2019	-0.007	0.601	11
R25mm	1921	2019	-0.013	0.264	8
cdd	1921	2019	0.024	0.872	191
cwd	1921	2019	-0.004	0.463	7
r95p	1921	2019	0.077	0.838	215.5
r99p	1921	2019	0.157	0.527	0
prcptot	1921	2019	0.097	0.873	606.9

**Table 97.** WMO ETCCDI rainfall index trends and values for RIETFontein SAPS (District 94). P-values below 0.05 indicate the trend to be significant at the 5% level.

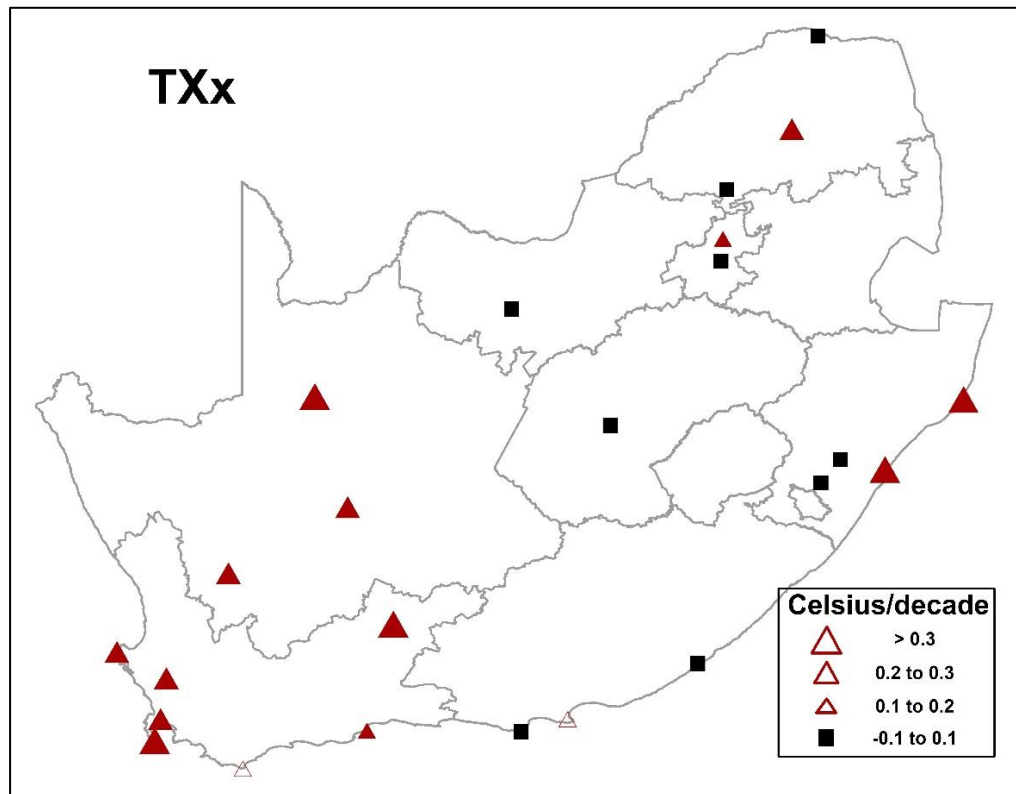
Indices	Start Year	End Year	Slope	P_Value	2019 value
rx1day	1921	2019	0.035	0.527	25.0
rx5day	1921	2019	0.219	0.038	25.0
sdii	1921	2019	0.053	0	25.0
r10mm	1921	2019	0.042	0.003	1
r20mm	1921	2019	0.015	0.082	1
R25mm	1921	2019	0.009	0.16	1
cdd	1921	2019	0.085	0.712	326
cwd	1921	2019	0.005	0.231	1
r95p	1921	2019	0.052	0.763	0
r99p	1921	2019	0.003	0.978	0
prcptot	1921	2019	0.476	0.192	25.0



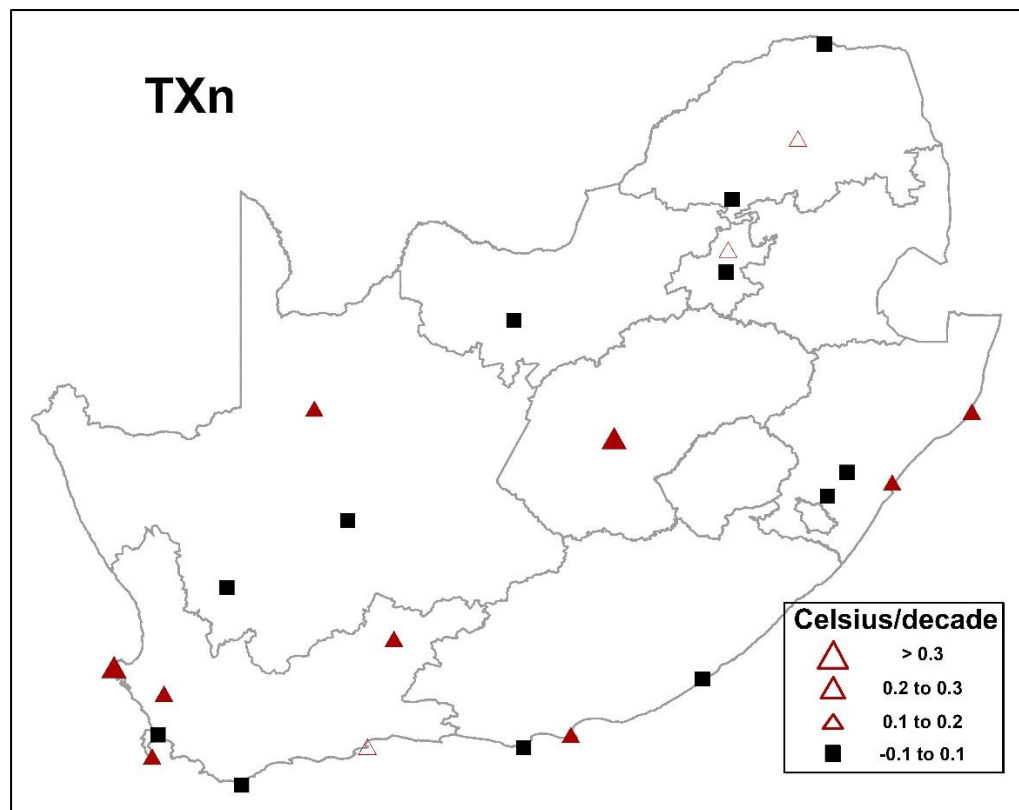
## 5. Maps of Extreme Index Trends

### 5.1 Temperature

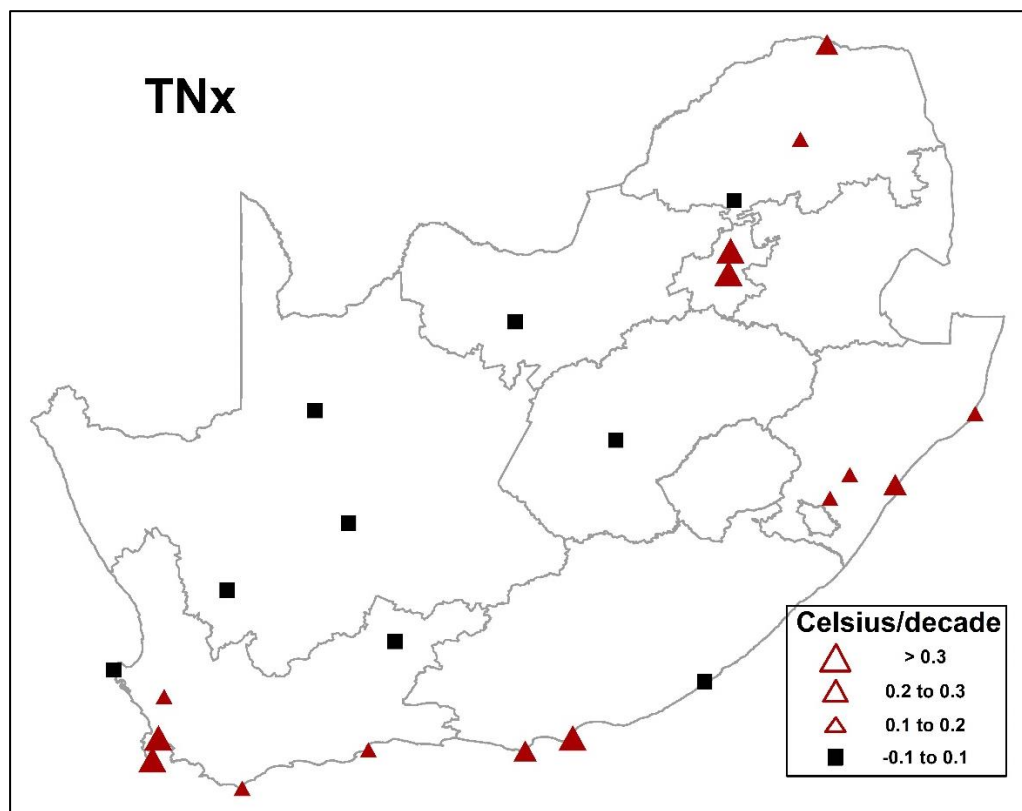
Figures 3 to 11 present the surface temperature extreme index trends for the stations of which the trend details are provided in Tables 4 to 27, in the same sequence as the details in the tables.



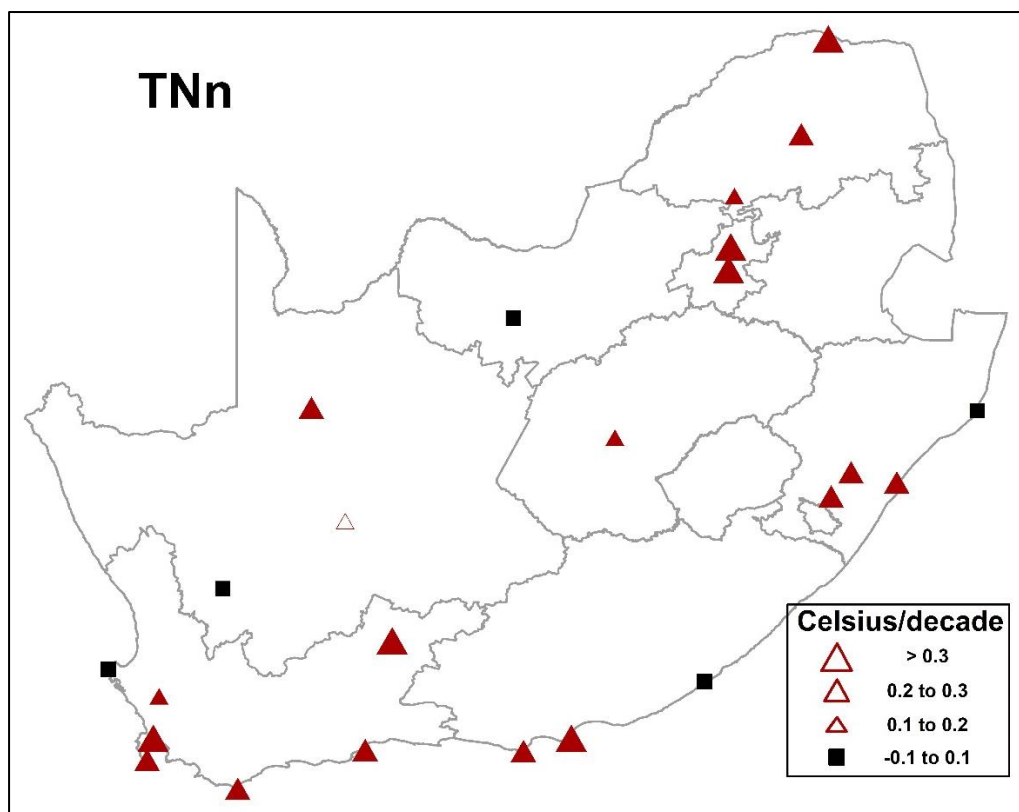
**Figure 3.** Trends in annual extreme temperatures: TXx in °C per decade – 1931-2019 (filled triangles denote significant trends at the 5% level).



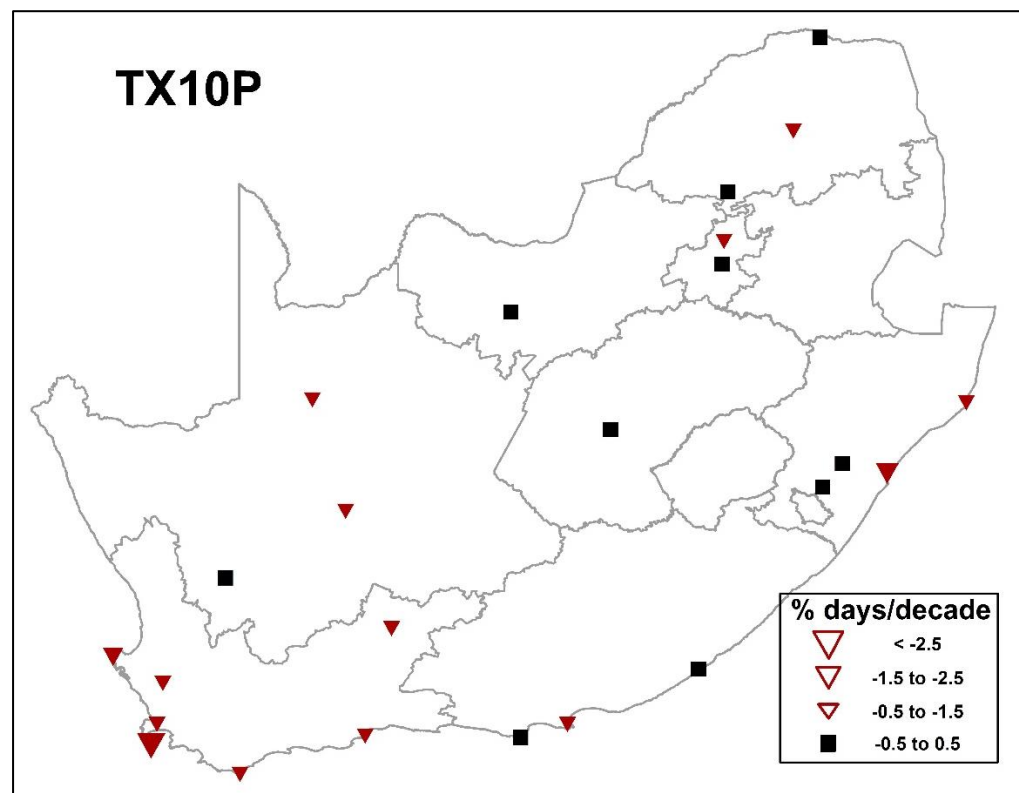
**Figure 4.** Trends in annual extreme temperatures: TXn in °C per decade – 1931-2019 (filled triangles denote significant trends at the 5% level).



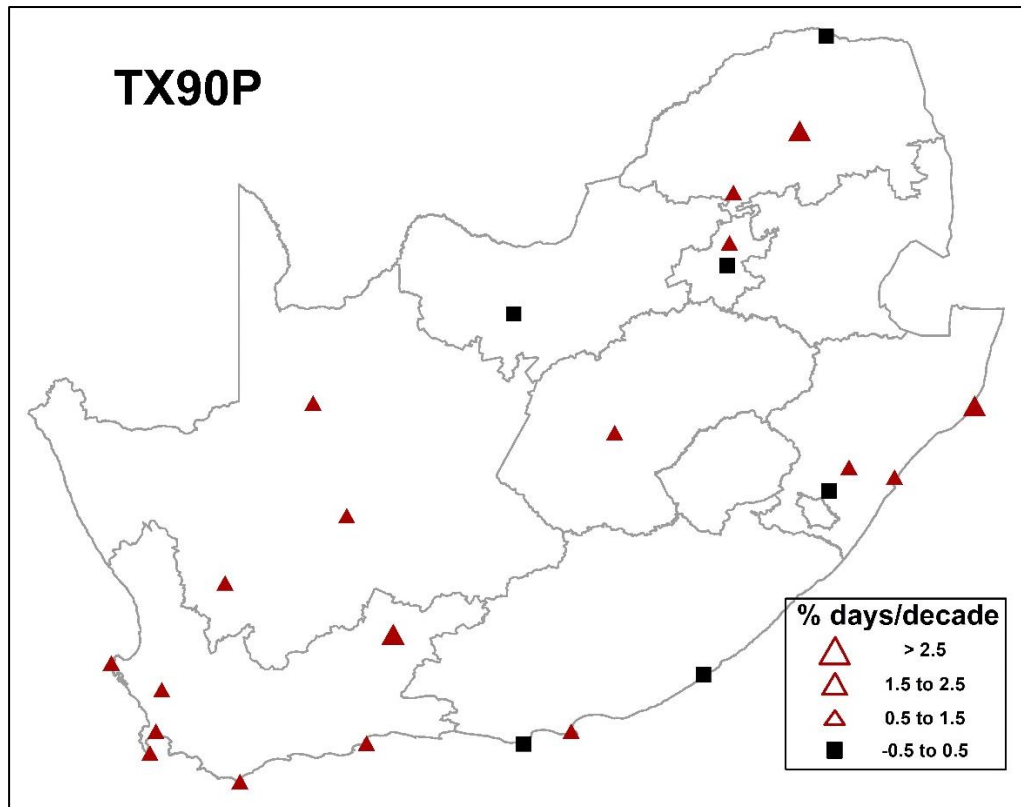
**Figure 5.** Trends in annual extreme temperatures: TNx in °C per decade – 1931-2019 (filled triangles denote significant trends at the 5% level).



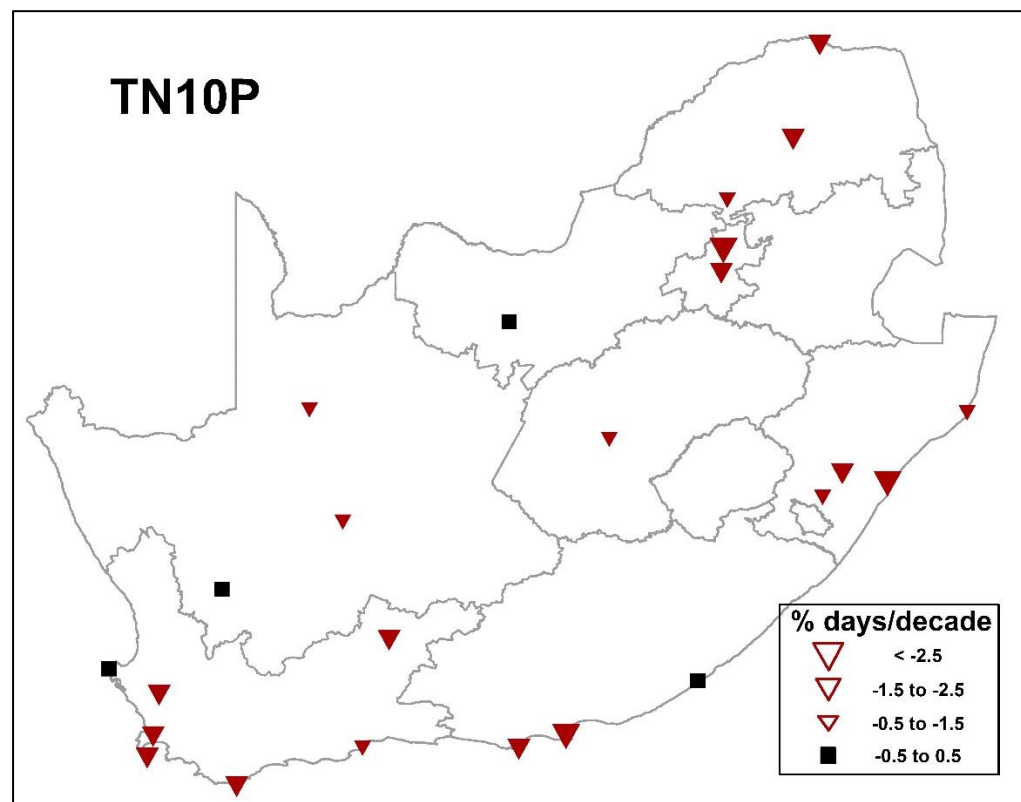
**Figure 6.** Trends in annual extreme temperatures: TNn in °C per decade – 1931-2019 (filled triangles denote significant trends at the 5% level).



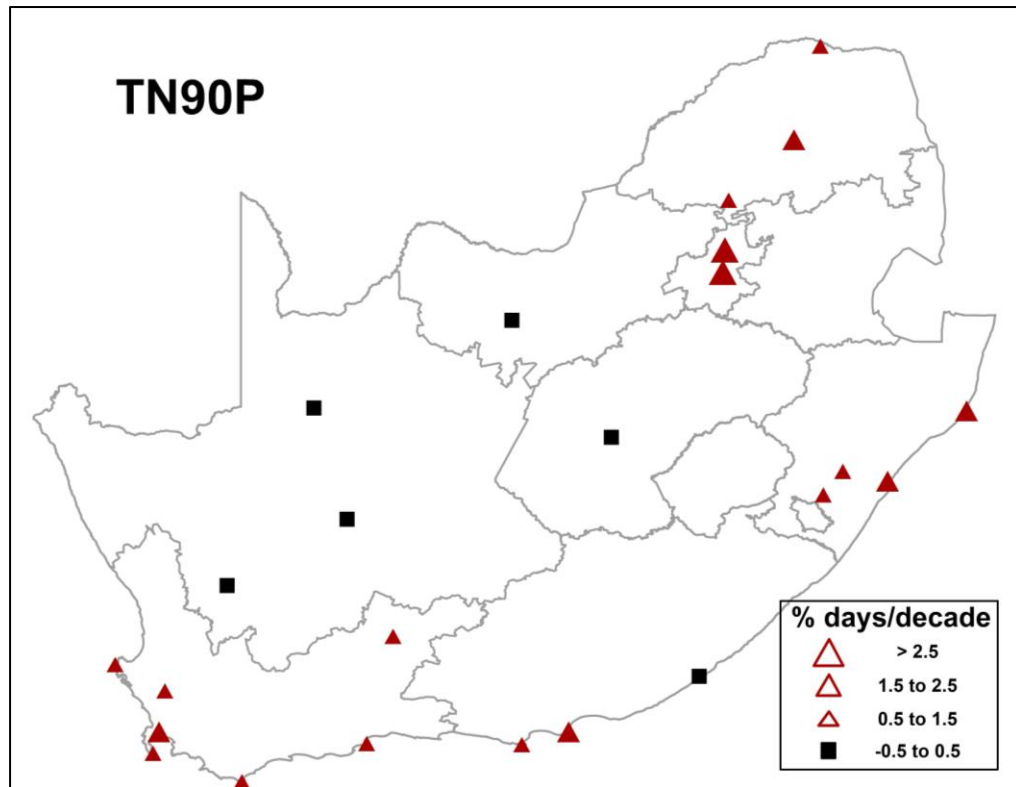
**Figure 7.** Trends in cool days: TX10P for the period 1931–2019 in % days per decade (filled triangles denote significant trends at the 5% level).



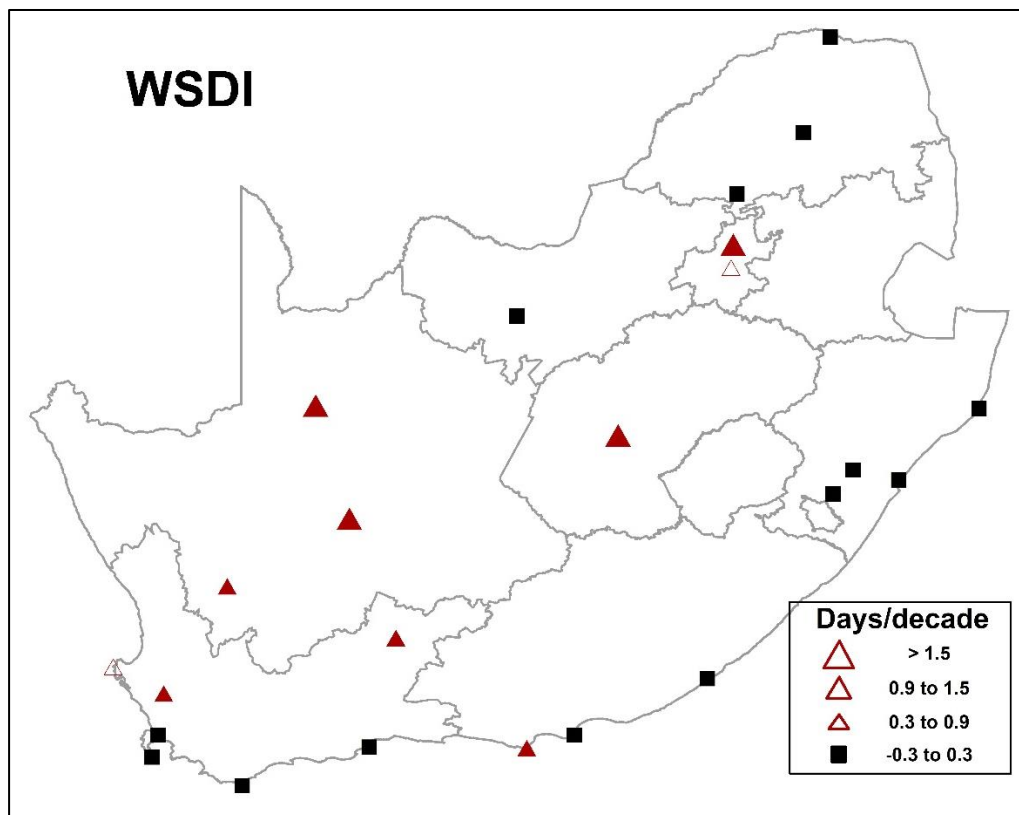
**Figure 8.** Trends in hot days: TX90P for the period 1931–2019 in % days per decade (filled triangles denote significant trends at the 5% level).



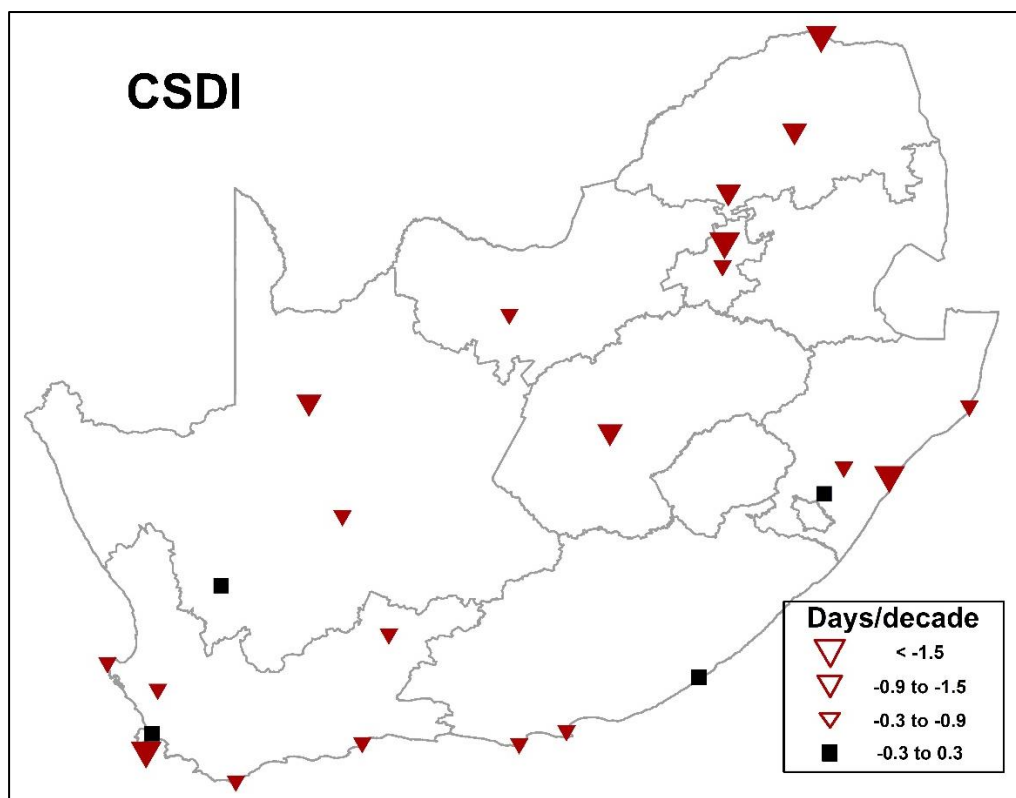
**Figure 9.** Trends in cold nights: TN10P for the period 1931–2019 in % days per decade (filled triangles denote significant trends at the 5% level).



**Figure 10.** Trends in warm nights: TN10P for the period 1931–2019 in % days per decade (filled triangles denote significant trends at the 5% level).



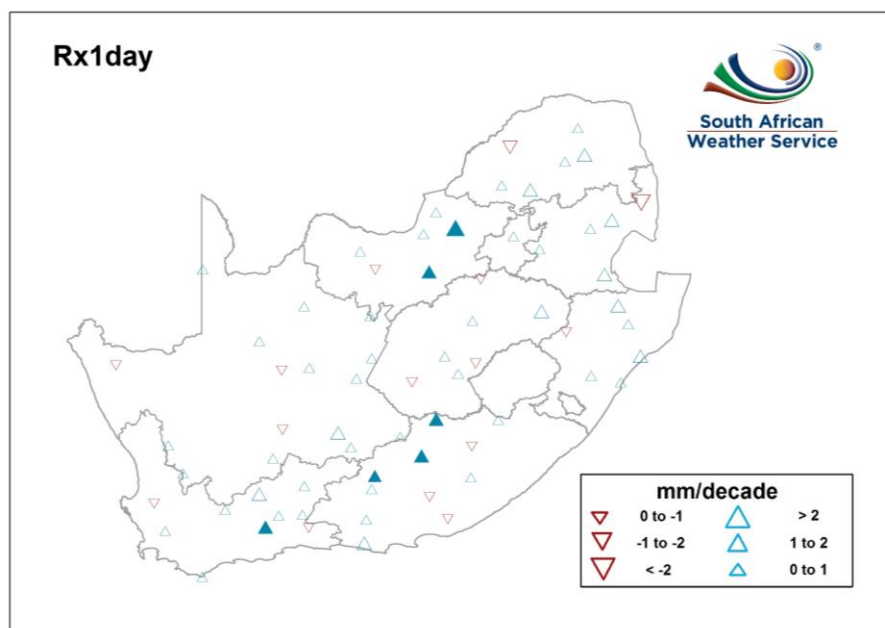
**Figure 11.** Trends in warm spells durations in days per decade: WSDI over the period 1931 – 2019 (filled triangles denote significant trends at the 5% level).



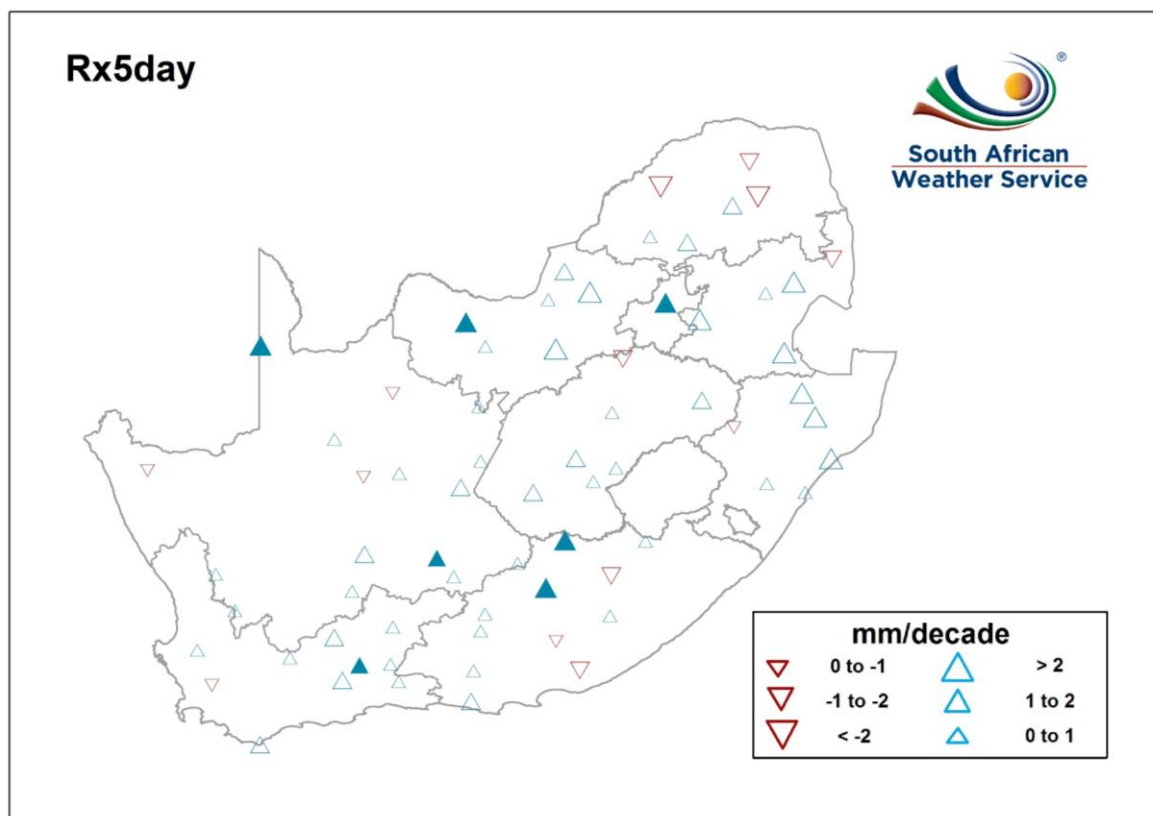
**Figure 12.** Trends in cold spells durations in days per decade: CSDI over the period 1931 – 2019 (filled triangles denote significant trends at the 5% level).

## 5.2 Rainfall

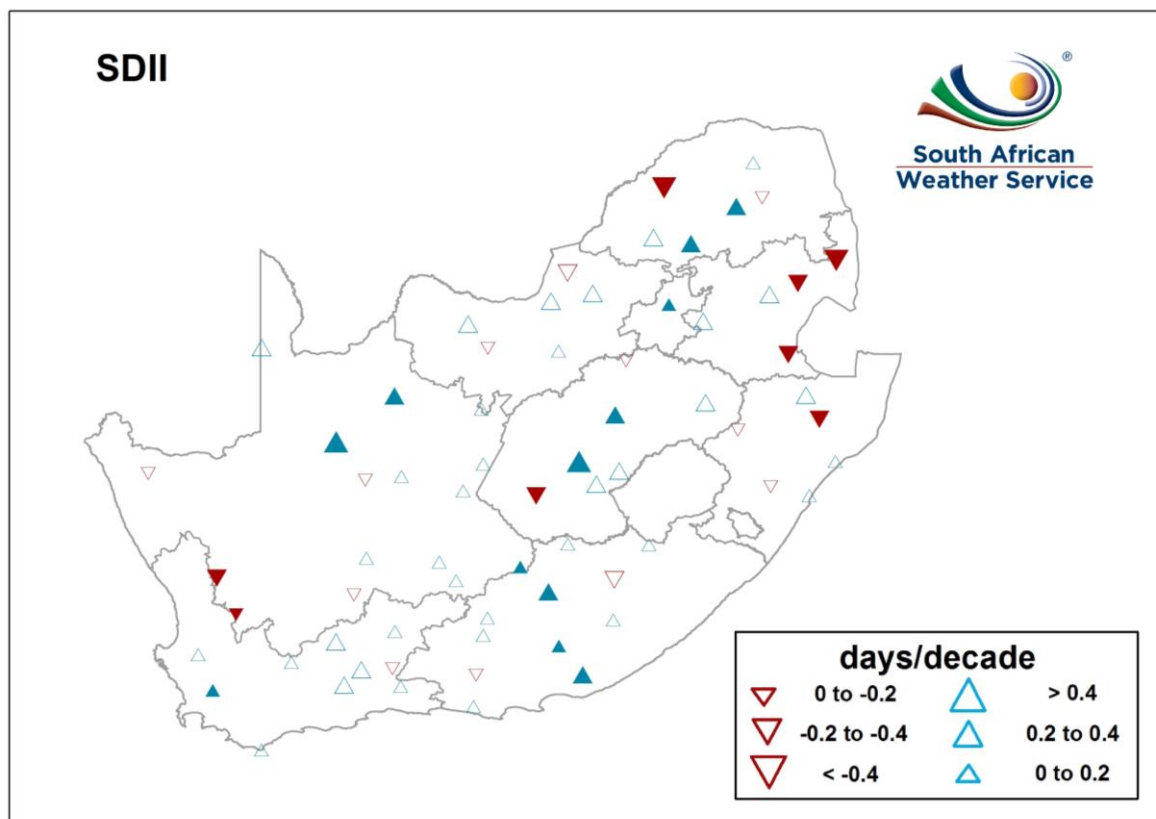
Figures 13 to 23 present the rainfall extreme index trends for the stations of which the trend details are provided in Tables 28 to 97, in the same sequence as the details in the tables.



**Figure 13.** Trends in rx1day, the annual maximum 1-day precipitation, for the period 1921–2019. Shaded symbols indicate statistical significance at the 5% level.

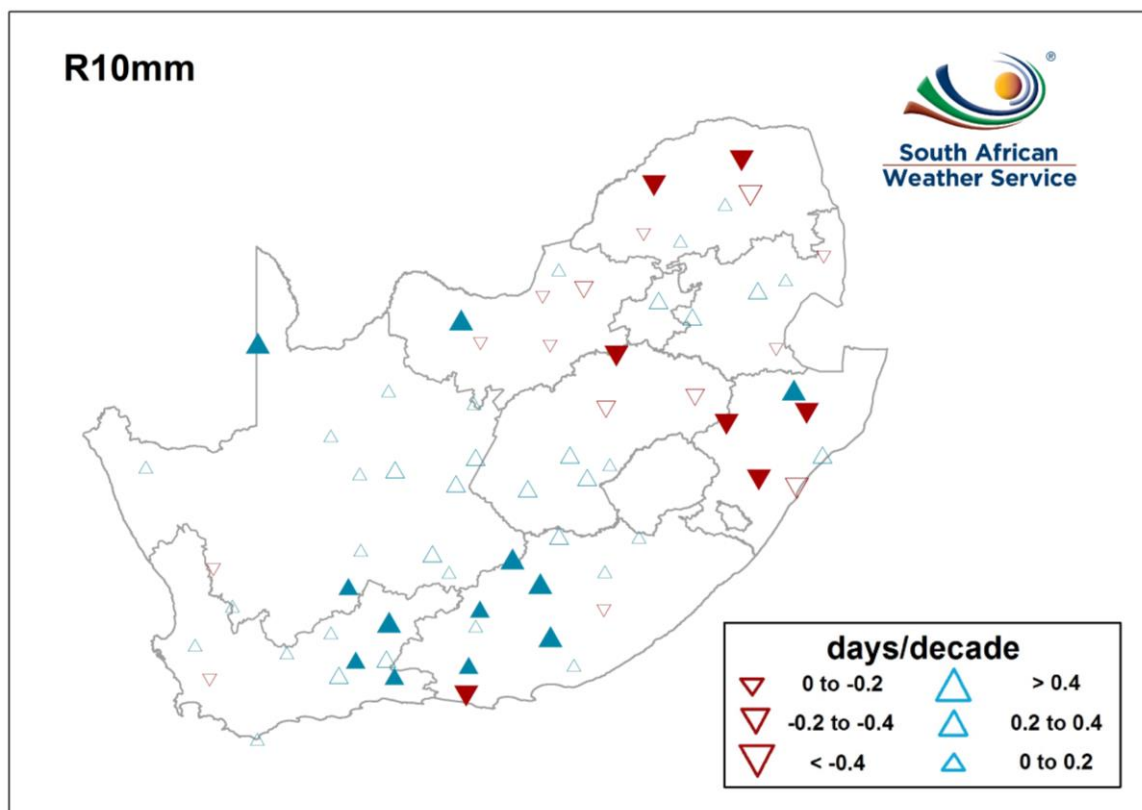


**Figure 14.** Trends in rx5day, the annual maximum 5-day precipitation, for the period 1921–2019. Shaded symbols indicate statistical significance at the 5% level.

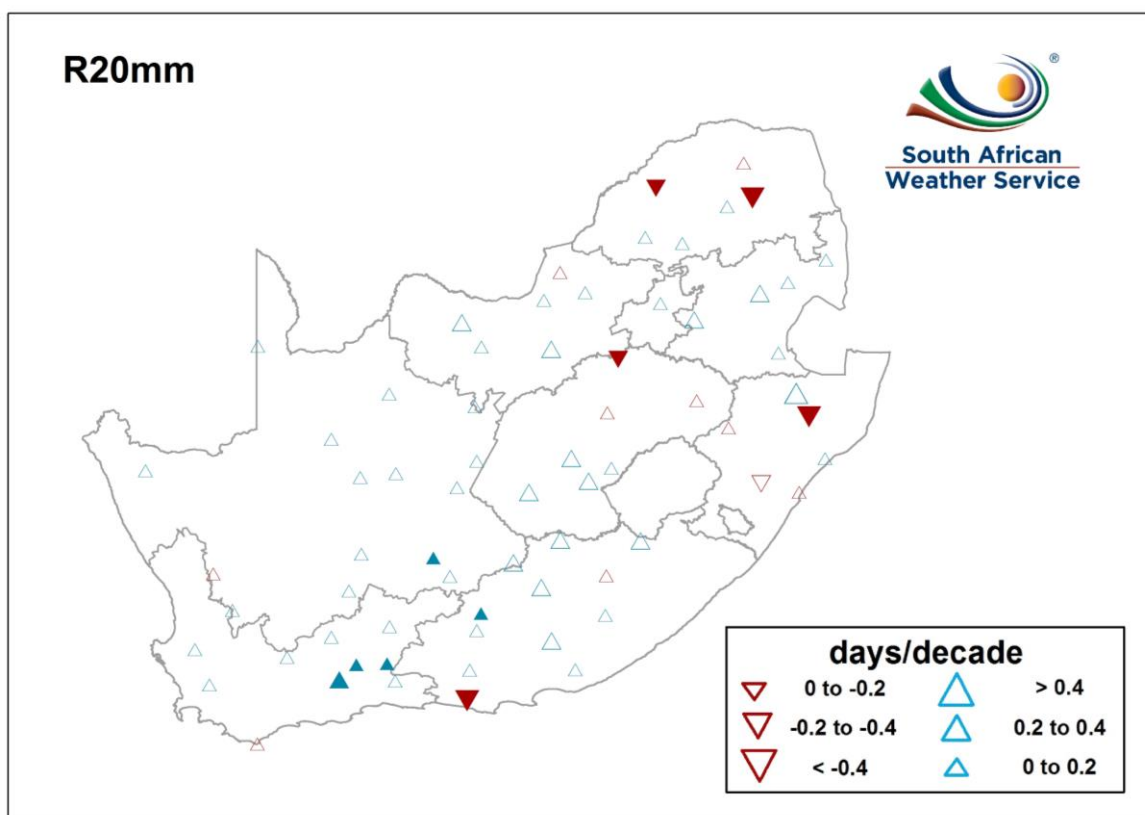


**Figure 15.** Trends in SDII, the rainfall intensity (amount) on rainy days, for the period 1921–2019. Shaded symbols indicate statistical significance at the 5% level.



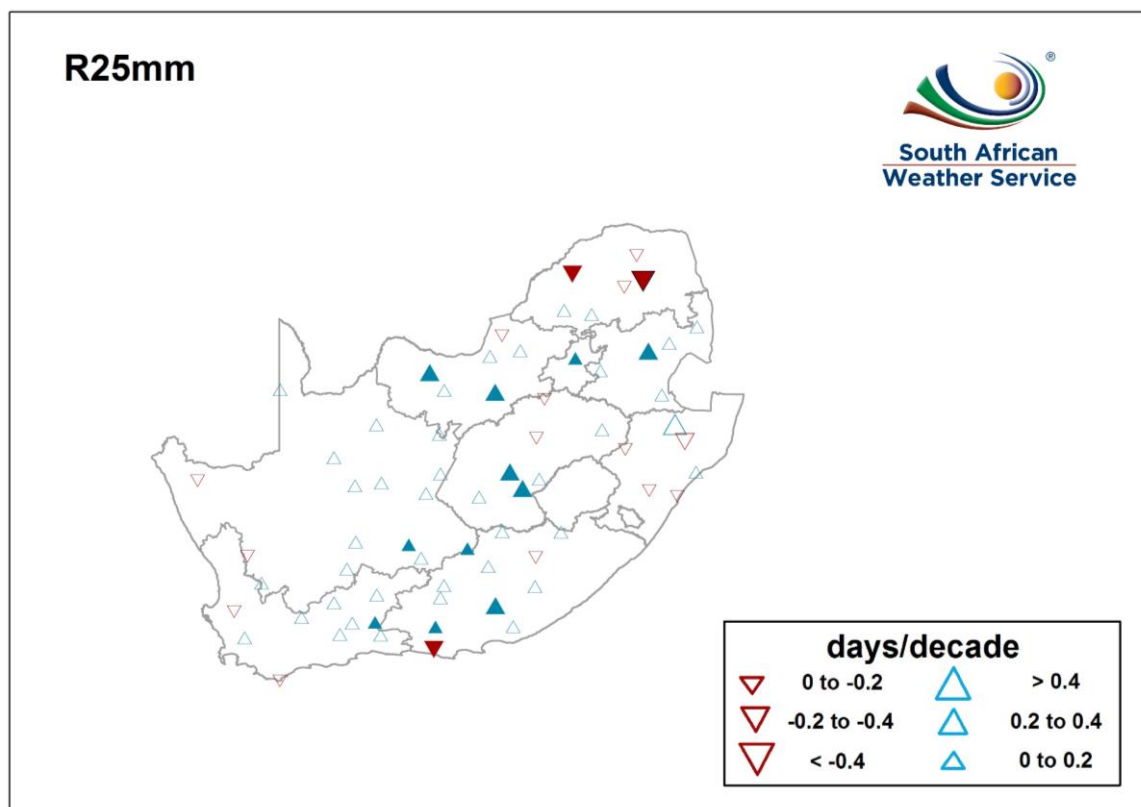


**Figure 16.** Trends in r10mm, the annual number of days with precipitation > 10mm, for the period 1921–2019. Shaded symbols indicate statistical significance at the 5% level.

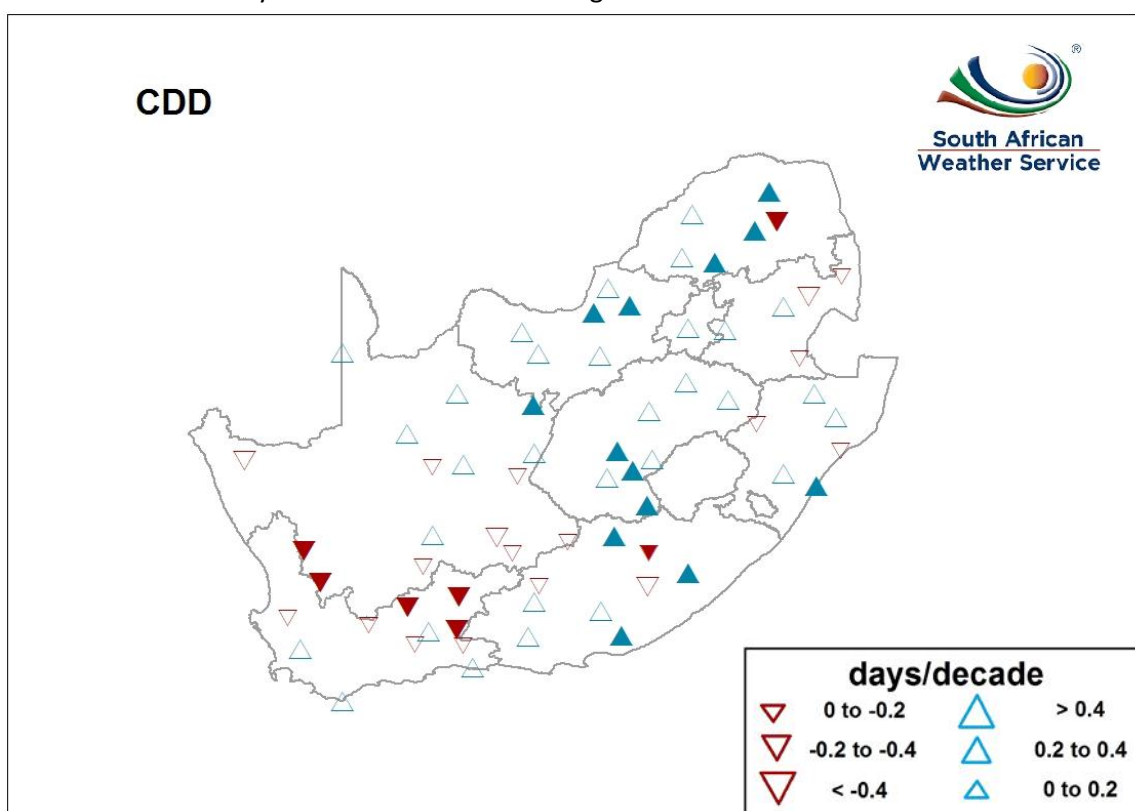


**Figure 17.** Trends in r20mm, the annual number of days with precipitation > 20mm, for the period 1921–2019. Shaded symbols indicate statistical significance at the 5% level.

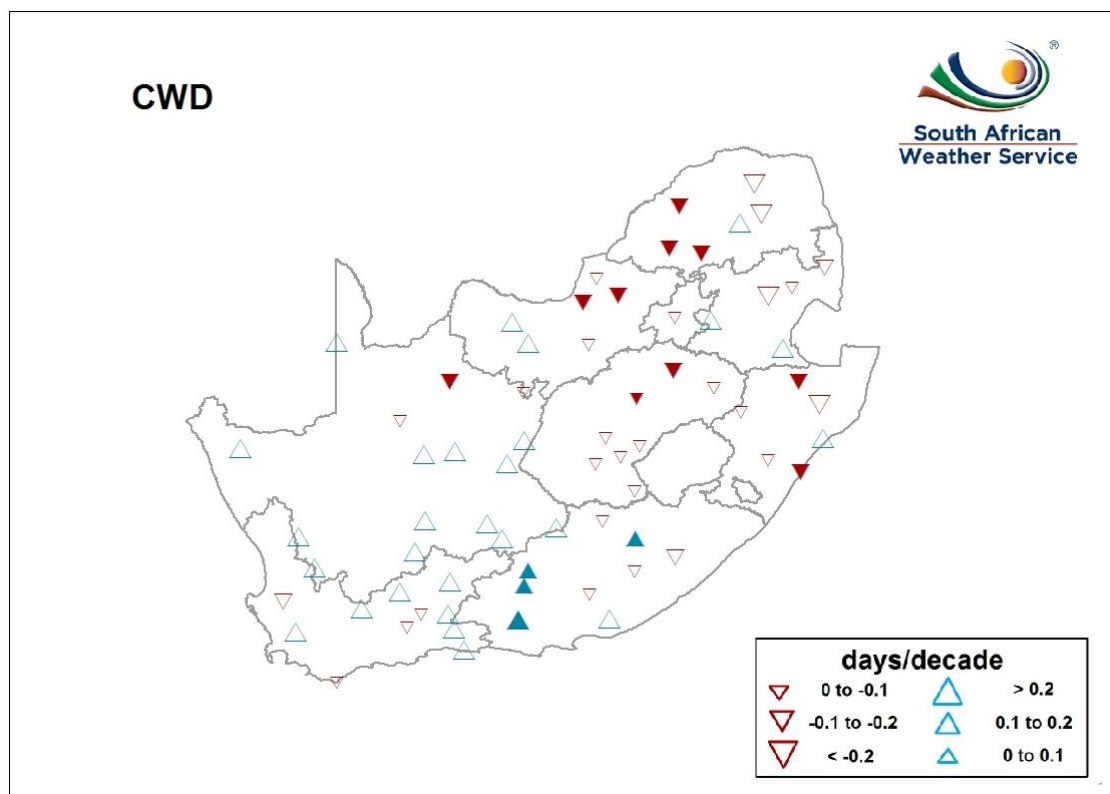




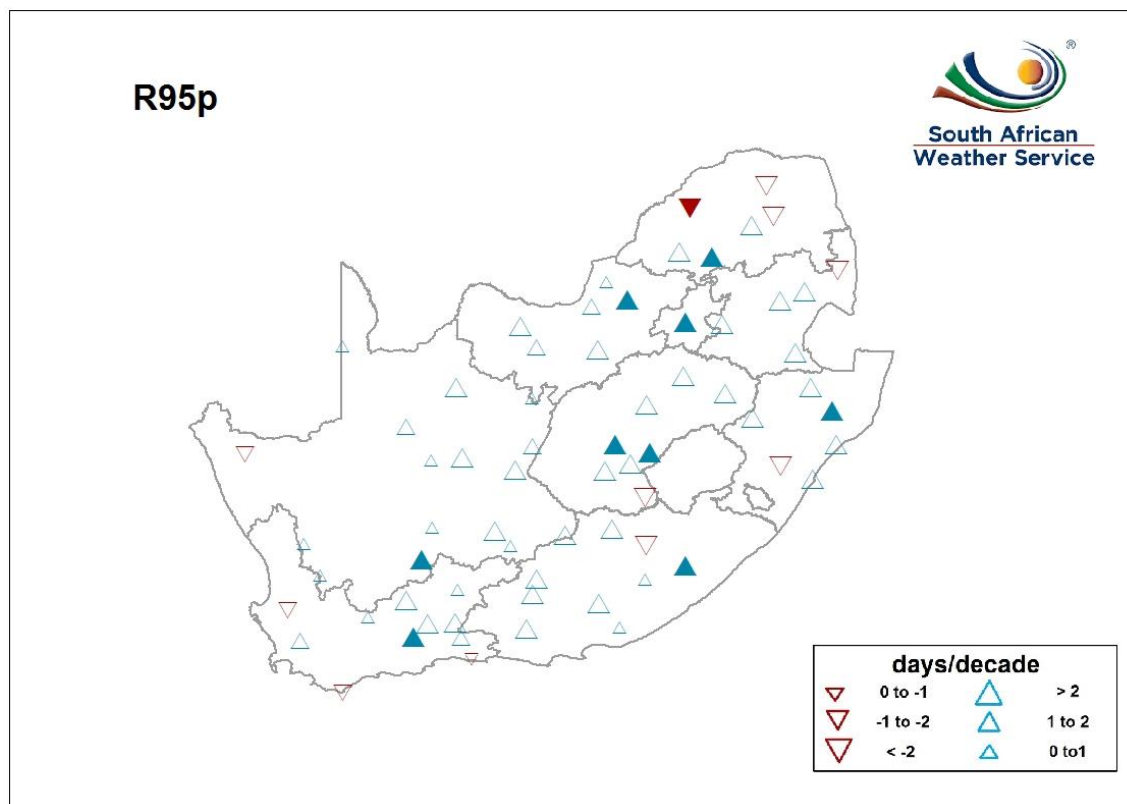
**Figure 18.** Trends in r25mm, the annual number of days with precipitation > 25mm, for the period 1921–2019. Shaded symbols indicate statistical significance at the 5% level.



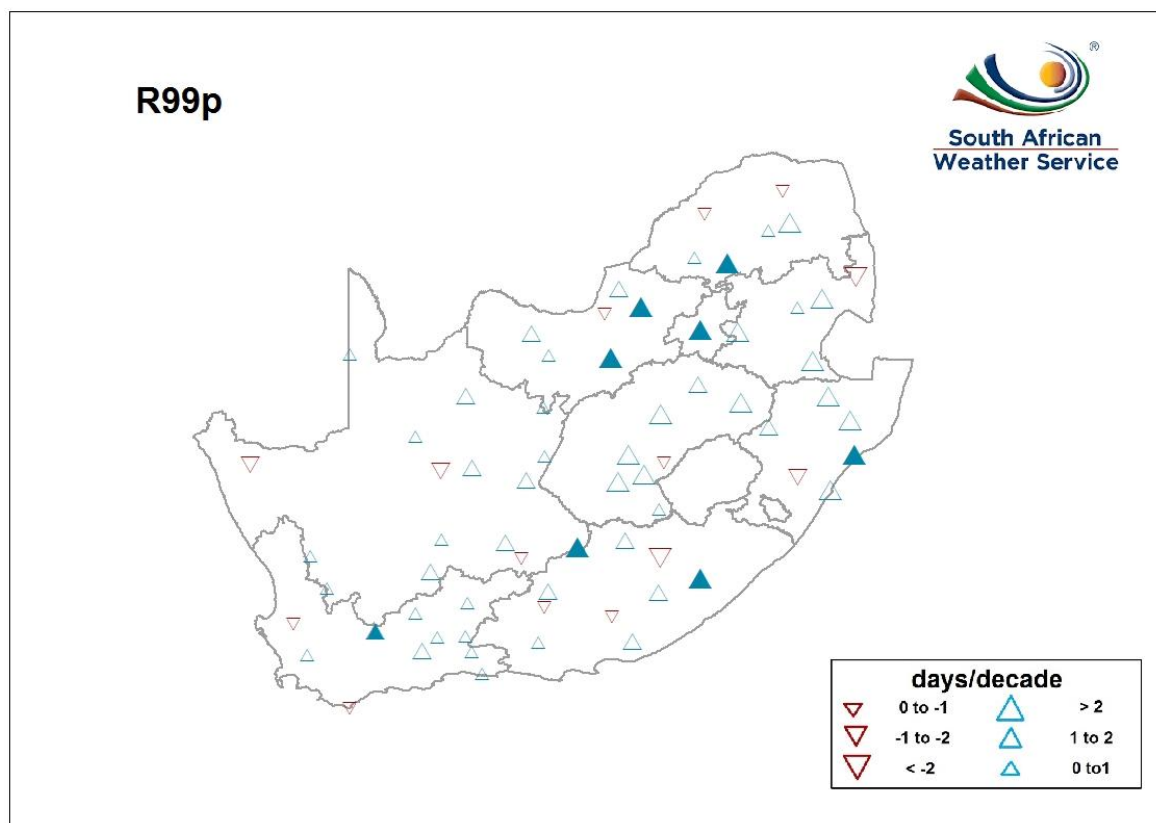
**Figure 19.** Trends in CDD, the annual maximum number of consecutive dry days, for the period 1921–2018. Shaded symbols indicate statistical significance at the 5% level (note that here blue upright triangles indicate increases in CDD and brown inversed triangles decreases).



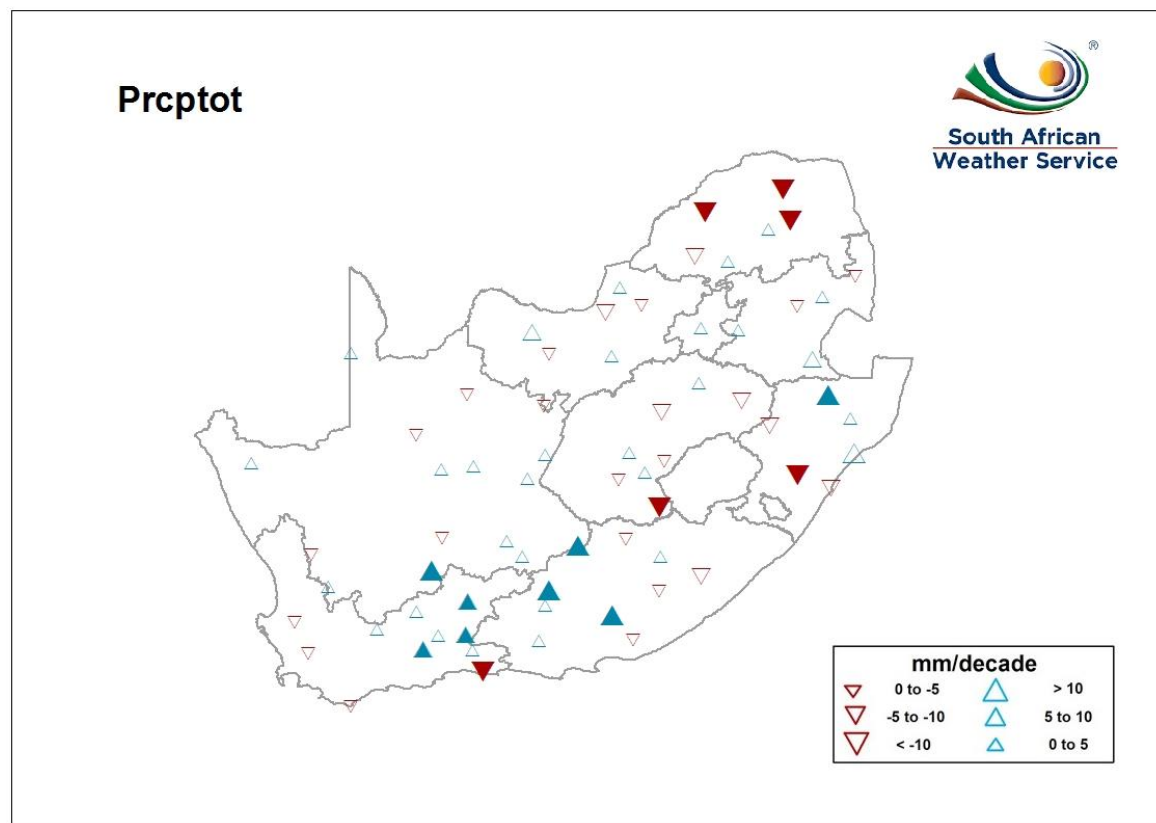
**Figure 20.** Trends in CWD, the annual maximum number of consecutive wet days, for the period 1921–2018. Shaded symbols indicate statistical significance at the 5% level.



**Figure 21.** Trends in r95p, the annual precipitation from daily precipitation > 95th percentile (base period: 1981 – 2010), for the period 1921–2018. Shaded symbols indicate statistical significance at the 5% level.



**Figure 22.** Trends in r99p, the annual precipitation from daily precipitation > 99th percentile (base period: 1981 – 2010), for the period 1921–2018. Shaded symbols indicate statistical significance at the 5% level.



**Figure 23.** Trends in prcptot, the annual precipitation from daily precipitation  $\geq 1$ mm, for the period 1921–2018. Shaded symbols indicate statistical significance at the 5% level.

## 6. Summary

The main conclusions that can be drawn from the trend results are the following:

Surface temperature: There is a general warming trend over South Africa over the period 1931 – present. Annual maximum temperatures are showing an increase in especially the western half of the country (Fig. 3), while annual highest daily minimum temperatures are showing significant increases especially along the coast and parts of the northern interior (Fig. 5). The lowest minimum temperature per year shows significant increases almost countrywide (Fig. 6). Generally cool days are decreasing (Fig. 8) and hot days increasing (Fig. 8). Similarly, cold nights are decreasing (Fig. 9) and warm nights increasing (Fig. 10), but not in the central interior. However, the annual maximum warm spells have increased significantly over the western and central interior (Fig 11). In contrast the maximum annual cold spell lengths have decreased countrywide (Fig. 12.)

In contrast with surface temperature, where all the extreme indices can be linked to a general warming trend, mixed trends are presented by the trends in extreme rainfall indices analysed over the period 1921 – 2019. Most indices can be associated with a decreasing trend in annual rainfall in isolated regions in the eastern and far northern interior with weaker drying signals in the south-west, while increases in rainfall are shown in the southern interior (Fig. 23). The annual maximum daily and five-daily rainfalls show significant increases in the central and southern interior (Figs. 13 and 14). Trends in the intensity of rainfall on rainy days show mixed signals, but there are clear decreases in the far north-eastern interior and increases in the central and south-eastern parts (Fig. 15). Trends in days with daily rainfall above the specific thresholds of 10mm and 20mm mostly indicate increases in the western and southern interior and decreases in the east and north-east (Figs. 16 and 17). However, in the case of the 25mm threshold increases are apparent over the central and southern interior and spreading eastwards, while decreases are only apparent in the far north (Fig 18). The annual maximum dry spells are increasing over most of the summer rainfall areas but decreasing in the south-western interior, which can indicate that winter rainfalls in the regions with predominantly summer rainfall are diminishing (Fig. 19). The annual maximum spells of wet days are decreasing in the north-eastern half of South Africa but there are signals of significant increases in the south-eastern interior (Fig. 19). Figs. 21 and 22 indicate that in general, i.e. over most of South Africa, daily rainfall that are considered to be relatively high are increasing.

## References

Donat, M. G. et al. 2013. Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: The HadEX2 dataset. Journal of Geophysical Research.

Kruger, A. C. & M. Nxumalo. 2016. Surface temperature trends from homogenized time series in South Africa: 1931–2015. International Journal of Climatology. DOI: 10.1002/joc.4851

Kruger AC, Nxumalo MP. 2017. Historical rainfall trends in South Africa: 1921–2015. Water SA. 43(2): 285 – 297. <http://dx.doi.org/10.4314/wsa.v43i2.12>

Zhang X, Yang F. 2004. RClimDex (1.0):Manual. Environment Canada: Ontario, Canada.

*End of document*