RAINFALL TRENDS IN THE AGRO-ECOLOGICAL ZONES OF ZAMBIA

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The Agro-ecological zones of Zambia and the meteorological stations within each zone

Data

We have analyzed 40 years (1960-2000) of daily rainfall data obtained from the Zambia Meteorological Department. The data was screened for negative values. Only some stations had complete daily rainfall time series from 1960 to 2000. Other stations had less than 40 years of data due to station opening after 1960 or having missing data. We have used meteorological years in the analysis assuming a meteorological year starts on 1 September and ends on 31 August. This choice of the period was made on the fact that Zambia has only one raining season in a year which spans from October to April of the following year. Therefore a meteorological year is chosen to capture a complete raining season in a year.

Methods

The annual daily rainfall for stations, which have complete 40 years (1960-1999) time series of daily rainfall is put in one of the five classes : class 1 (0-0.5 mm), class 2 (0.5-5 mm), class 3 (5-10 mm), class 4 (10-25 mm) and class 5 (>25 mm). Class 1 refers to dry days or nearly dry days where as classes 2 to 5 refer to wet days. Class 5 refers to high intensity rainfall days.

Similar analysis is done for the three Agro-Ecological zones by averaging the daily rainfall across the meteorological stations which fall in each zone. All statistics for the agro-ecological zones were calculated from the every possible station data available without discarding any .

Simple linear regression is performed to establish trends for the variables namely (i) annual number of days in classes from two to five (ii) annual number of wet days and (iii) annual rainfall amount, for individual stations as well as for the three Agro-Ecological zones. The Student's t-tests are carried out to determine the significance of trends. The level of significance used in the trend analysis is set to 0.10.

40 years mean of annual number of days and annual rainfall amount in five classes for Livingstone

Classes	Mean number of days/year	Std.dev	Mean amount(mm)/year	Std.dev(mm)
1	301.38	11.96	3.38	1.6
2	30.45	6.6	68.31	15.77
3	11.73	4.08	84.88	29.68
4	14.45	4.41	227.97	69.83
5	7	3.0	286.81	124.77
Total	365.01		671.35	

40 years mean of annual number of days and annual rainfall amount in five classes for Chipata

Classes	Mean number of days/year	Std.dev	Mean amount(mm)/year	Std.dev(mm)
1	282.48	11.66	3.06	1.45
2	33.83	6.19	78.09	16.25
3	16.35	5.68	118.7	42.28
4	20.55	4.89	331.57	82.59
5	11.8	3.63	458.61	158.31
Total	365.01		990.03	

40 years mean of annual number of days and annual rainfall amount in five classes for Kasama

Classes	Mean number of days/year	Std.dev	Mean amount(mm)/year	Std.dev(mm)
1	260	11.72	3.73	2.21
2	40.58	5.22	96.78	16.57
3	20.95	4.83	152.4	34.22
4	28.53	5.31	464.18	88.49
5	14.95	3.53	594.91	149.20
Total	365.01		1312	

40 years mean of annual wet days and annual rainfall amount for the Agro – Ecological zones

Agro-Ecological zone	Mean wet days/year	Std.dev	Mean amount (mm)/year	Std.dev
1	94.1	15.3	690.98	145.3
2	146	11.4	859.59	149.8
3	173.78	14.59	1189.18	133.90

Trends in number of days in classes from 2 to 5 for station Livingstone in Agro-ecological zone 1 . The significant trends are in the bold numbers

Class	Trend
2	**-0.156**
3	**-0.141**
4	**-0.133**
5	-0.021

Trend in annual number of wet days and annual rain fall amount for station in Agro-Ecological zone 1

Station	Trend (wet days /year)	Trend in annual rainfall amount(mm/year)
Livingstone	**-0.451**	**-4.007**

Trends in number of days in classes from 2 to 5 for stations in Agro- Ecological zone 2

Class	Chipata	Choma	Kabwe	Kafue	Kaoma	Mongu	MtMakulu	Petauke
2	-0.019	-0.03	-0.006	-0.081	0.047	-0.08	0.10	-0.111
3	**-0.256**	-0.09	-0.078	**-0.110**	**-0.180**	**-0.16**	**-0.175**	**-0.121**
4	-0.102	-0.08	-0.010	-0.019	**-0.171**	-0.08	-0.061	-0.099
5	**-0.092**	-0.05	**-0.130**	0.012	-0.030	0.007	0.056	-0.007

Trend in annual number of wet days and annual rain fall amount for stations in Agro-Ecological zone 2

Station	Trend (wet days/year)	Trend in annual rainfall amount (mm/year)
Chipata	**-0.4708**	**-5.72**
Choma	-0.25	-2.45
Kabwe	-0.2240	**-5.95**
Kafue	-0.222	-1.12
Kaoma	**-0.3350**	-4.35
Mongu	**-0.3086**	-2.77
MtMakulu	-0.0779	0.8918
Petauke	**-0.3387**	-1.95

Trends in number of days in classes from 2 to 5 for stations in Agro- Ecological zone 3

Class	Kasama	Mpika	Ndola
2	-0.109	-0.023	-0.045
3	**-0.157**	**-0.227**	-0.096
4	-0.080	-0.042	-0.018
5	-0.022	-0.019	**-0.117**

Trend in annual number of wet days and annual rain fall amount for stations in Agro-Ecological zone 3

Station	Trend (rain days/year)	Trend in annual rainfall amount (mm/year)
Kasama	**-0.369**	-4.215
Mpika	**-0.314**	-2.167
Ndola	**-0.278**	**-6.140**

Trends in annual number of days in classes 2 to 5 in the three Agro-ecological zones

Zones	Class2 (0.5-5 mm)	Class 3 (5-10 mm)	Class4 (10-25 mm)	Class 5 (>25 mm)
1	**0.569**	**0.222**	-0.103	**-0.059**
2	-0.135	-0.058	-0.140	0.0008
3	-0.138	-0.177	**-0.201**	0.015

Trends in annual number of wet days and rainfall amount in three Agro-Ecological zones

Zone	Annual number of wet days	Annual rainfall amount
1	**0.629**	-1.038
2	**-0.333**	-3.269
3	**-0.502**	**-4.124**

Implications on Agriculture

Agro-ecological zone 1 was most suitable for production of traditional crops like maize and beans. However the recent deficits in rainfall amounts are moving the farming from zone 1 to zone 2 and 3. These zones are also experiencing decreasing trends in annual rainfall totals. Therefore there is an urgent need of adaptations in agriculture to combat climate change.