

Title: Detection of inhomogeneities in the national climate dataset (1902-2003) of Uganda

BY

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1. Rationale.

Detection of meteorological trends associated with climate change requires the elimination of errors associated with observations and record keeping. Excessive rainfall raises the water table and excessive drought lowers it, accurate records of Maximum Annual Rainfall (MAR) and Consecutive (zero) Dry Days (CDD) are critical to assessments of climate impact on ground water.

2. Background: In Uganda, the records existed in manuscript formats and were on the verge of wear and tear where very little QC could be done on them in this state. The 1998-2001 HYDROCLIMATIC STUDY project did a tremendous job to digitise the climate data. During this exercise a total of 596 rainfall stations and 20 temperature station records were digitised using CLICOM software which generated 16,9200 records of station data years.

Climate data is a key component of water resource management. It should be noted that pictures of extreme weather like the hail storms in Mbarara (Fig 1) cannot explain trends of climate change. The graph (Fig 2a) shows 2005 and 1983 as the warmest years since 1935 for Kabale. (Fig 2b) shows that 2008 is slated to be on record as the coldest year in the past 45yrs confirming the WMO Secretary General's speech.

Fig 2a

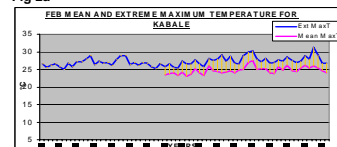


Fig 2b

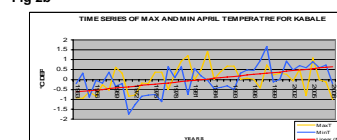


Fig 1



4. Methodology.

DATA: Temperature and precipitation data were used because they are the basic parameters for investigations in climate trends. Fig 6a showing all rainfall station series existing on Uganda database. Synoptic stations with long data series of over 50 years depending on their location were chosen for homogenization testing.

METADATA: Available metadata is only about station histories & geography but it is easy to trace back on some of the events which have impacted on the data.

ISSUE OF DATA QUALITY CONTROL: Staff at UMD using CLICOM (Fig 6b) to process the data, CLICOM can unfortunately only do level 1 Quality Control (QC). A number of tests were therefore tried out to clean the data and these include:

1. Identification of repeated data
2. Identification of outliers from expected values.
3. Comparative tests using neighbouring stations
4. Suspicious zero values
5. Orphan Months
6. Excessive maximum daily rainfall

HOMOGENISATION METHODS USED:

1. Metadata:
2. Use of single station data with normalized departure:
3. Bдуш homogenization method is based on the cumulative deviation from the means.

Fig 6



3. Objective

To isolate errors and inhomogeneities existing in the Uganda climatological datasets such that analysis of climate change and ground water management can be relied upon.

DISCUSSION: 1) BOTH CONFIRMED CONSISTENT & INCONSISTENT LOWEST ANNUAL RAINFALL ARE IDENTIFIED WITHIN THE DATASETS. 2) ALL THESE STATIONS ARE FOUND IN THE CATTLE CORRIDOR. 3) RUGAGA IN SW UGANDA RECEIVING 310mm CONFIRMED CONSISTENT ANNUAL FALL ALMOST SAME AS KOTIDO. 4) META DATA SHOWS 245mm OF SUSPICIOUS ANNUAL RAINFALL FOR SAMALIA WHERE THE FIRM OWNERS HAD LEFT IN 1975

Fig 5

ST NAME	ST-NUMBER	AMOUNT	YEAR	DISTRICT	ANNUAL
Ntunsi	89310120	321mm	1946	Sembabule	887mm
Rugaga	90310250	310mm	1968	Sembabule	696mm
Kijjudde	89320820	370 mm	1972	Mukono	1405mm
Samalia	90310240	245 mm	1975	Masaka	1116mm
Kyamate	90300450	173 mm	1981	Isingiro	757mm
Kotido	86340020	350mm	1965	Kotido	703mm
Ruhengeri	90300510	281 mm	1981	Mbarara	752mm
Kangole	87340090	374 m m	1974	Kotido	677mm
Kawungera	89310160	380mm	1954	Mubende	890mm



Results: SUSPICIOUS ZEROS OF MBIRIZI (Table 3) AND CONFIRMED 6 MONTHS OF CONSISTENT ZEROS IN KOTIDO (Table 4) 1953.

A statistical test at 99% showed no month of April with zero rainfall in Uganda. Note that there were upheavals in 1981 resulting into absenteeism by observers who recorded nil instead of missing as shown in table3 for Mbirizi.

Table 3

Kabongo 6months of confirmed consecutive zero rain between 1952-Oct to 1953-Mar

86340010	1949	0	41	0	105	134	64	150	203	34	1	0	18	751
86340010	1950	0	38	114	19	117	142	93	38	59	0	0	620	
86340010	1951	3	4	25	155	13	106	44	63	43	30	24	61	571
86340010	1952	0	10	13	118	192	15	86	266	47	0	0	747	
86340010	1953	0	0	0	82	15	220	57	112	40	60	16	602	
86340010	1954	0	4	0	167	115	110	187	158	82	0	0	823	
86340010	1955	0	5	103	0	91	160	298	206	28	42	17	970	

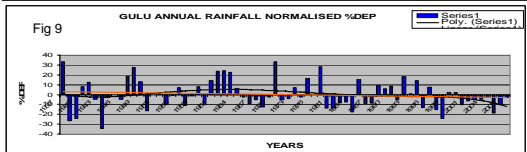
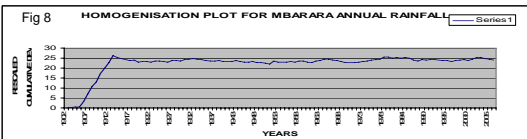
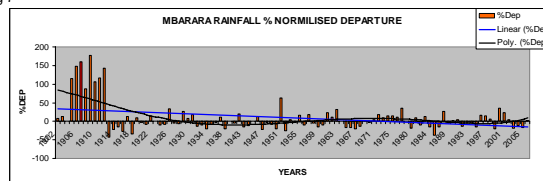
Suspicious zero April

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1968	m	m	m	m	m	97	15	91	99	191		
1969	34	215	150	116	159	140	0	79	229	152		
1970	8	37	151	228	58	21	60	134	175	92		
1971	0	16	13	0	0	69	97	141	188			
1972	233	150	134	238	149	35	0	71	66	72		
1973	78	92	56	185	172	51	11	53	223	147		

6. Conclusions.

1. Even after all the level one quality control is done inhomogeneity like those in Mbarara Fig 7 & Buvuma remains behind because they are within the limit, on daily basis.
2. In Uganda the inhomogeneity in datasets were mainly caused by wars, inefficient observers mainly at the opening and end closure of a station or t and lack of motivation.
3. Rigorous analysis like this, help to detect those suspicious zeros mistaken for missing data,

Fig 7



5. Discussion. Fig 8 & 9 shows inhomogeneity detected using Normalised and Bдуш homogenization tests at the beginning of the station. What remains contentious is that inhomogeneity are just identified but not adjusted. A need for a team work to agree on adjustment methods. Surprisingly, unlike temperature series, there are no significant trends in the rainfall time series as it is seen in Fig 9 of Gulu annual series. A fitted polynomial is just oscillating meaning that analysis of extremes using climate change indices of detection and attribution is required. Note that on the temperature, it's the maximum which is decreasing this year not the minimum which is on the lowest may be due to the fact that it's the OLR occurring at night is one suppressed. However This is not yet significant because tests must be done on all stations

Key references: List in abbreviated the key references

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7. Filipov V.V. Quality Control Procedures For Meteorological Data. WWW Planning Report No-26 P.14-28. Appendix E. 1968